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ABSTRACT

In order to identify the distinguishing characteristics of technical education programs in engineering and industrial technology currently offered by post-secondary institutions in California, a body of data was collected by visiting 25 community colleges, 5 state universities, and 8 industrial firms; by a questionnaire sampling of 72 California community colleges; and by conducting an Industry-Education Workshop. Based on these data, this publication gives classification guidelines for curricula within the engineering and industrial technology fields, identifies characteristics of the curriculum structures, and recommends core curricula for selected disciplines, including electronics technology, mechanical technology, electro-mechanical technology, and civil technology. Included in the discussions of the recommended core curricula are recommended prerequisites, a suggested curriculum sequence, suggested technical electives, course descriptions, and employment opportunities. Appended are: a description of data collecting procedures, and a copy of the survey instruments; articulation information for both engineering and industrial technology; supplementary information on the Unified Physics course; course descriptions of remedial courses; and a list of comments from industry. (NHM)

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TECHNOLOGY EDUCATION

ENGINEERING TECHNOLOGY & INDUSTRIAL TECHNOLOGY

IN

CALIFORNIA COMMUNITY COLLEGES

A CURRICULUM GUIDE

BY

James F. Schon
Project Director
City College of San Francisco
1976

This publication was prepared by The San Francisco Community College District in cooperation with California Community Colleges pursuant to funding under the Vocational Educational Act of 1968 (Public Law 90-576).

JC 760 243

FOREWORD

California Community Colleges offer many programs having a primary objective to prepare students for employment. These programs are designed and implemented to meet local or regional training and educational needs for specific occupations or occupational areas. More often than not, however, program and course objectives, titles and content are not as consistent or uniform throughout the state as they might be. A higher degree of uniformity would be of benefit for several reasons: understanding of what the various programs are and where they are offered, better knowledge of what the student has been exposed to and what employers can expect of graduates, and increased sharing among the colleges of course and curriculum content and methodology used to accomplish objectives.

This publication contains recommendations for the implementation of curricula standards, designations and content within engineering technology and industrial technology programs. A degree of uniformity within these programs to obtain the benefits mentioned above is recommended but sufficient flexibility is retained to satisfy any unique local needs. The basic requirements of the two programs as well as differences between the two are explained so that distinctions can be made. It is hoped that recommendations contained herein will be seriously considered.

Significant statewide input from educators and industrial representatives was obtained by the author during preparation of the guide. We're indebted to all those who contributed.

Leland P. Baldwin

Leland P. Baldwin
Assistant Chancellor
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PREFACE

In a community college, technical education is a vehicle which conveys students from an educational level, usually high school graduation, to a higher level of technical skills and personal capabilities. It is important to realize that this vehicle is not necessarily an express from high school graduation to the associate degree in a given technology curriculum. Rather, the student may disembark at any point along the route to transfer to another educational destination--or into employment. Attrition statistics confirm this proposition. It is therefore incumbent upon those concerned with the development and implementation of technical curriculums to provide educational opportunities which accommodate the mobility and changing objectives of the student.

It is the expressed purpose of this project to gather and analyse meaningful data which will distinguish the differential functions of engineering technology and industrial technology programs offered by California community colleges and to recommend core curriculums for selected disciplines. Many advantages could accrue from the adaptation of core curriculums. For example, students could transfer from one community college to another without serious loss of credit; communication between and among community colleges and four-year bachelor programs in Engineering Technology and Industrial Technology would be improved. Equally important is the fact that more uniform curriculum content and objectives would enable employers to establish employment criteria (job classifications) keyed to a known quality of the technician graduate. It would be reasonable to assume that employers could better understand and support technician programs offered by the community colleges if a greater degree of uniformity in curriculum content and quality could be achieved.

Louis F. Batmale

Louis F. Batmale, Chancellor/Superintendent
San Francisco Community College District

ACKNOWLEDGEMENTS

The quality of this publication is due to the generous contribution of time and energy of many individuals in industry and education. The writer gratefully acknowledges the active participation by these people to provide vital information and ensure the validity and practical worth of this curriculum guide.

A large measure of appreciation must be expressed to William K. Mayo, former chairman of the Department of Engineering and Dean of Instruction at City College of San Francisco, and to Louis F. Batmale, Chancellor of San Francisco Community College District. Their support and guidance were an important contribution to the pursuit of this project.

Special thanks goes to William M. Anderson of the Chancellor's Office of California Community Colleges for his assistance and patience, and to the Statewide Advisory Committee for their invaluable help in compiling information and drafting the material included in this booklet.

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The writer also acknowledges his indebtedness to the many individual community college faculty members and administrators who contributed information for this project and without whose assistance this report could never have been written.

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TABLE OF CONTENTS

Page

TITLE PAGE i

FOREWORD ii

PREFACE iii

ACKNOWLEDGEMENTS iv

PART I - INTRODUCTION 1

- A. Definitional Problems in Technical Education
- B. Project Goals
- C. Scope
- D. Summary of Procedures

PART II - CLASSIFICATION GUIDELINES 8

- A. Technical Education Spectrum
- B. (ET)/(IT) Boundary Identities
- C. Engineering Technology and Industrial Technology
- D. (ET)/(IT) Curriculum Structure Characteristics

PART III - CURRICULUM RECOMMENDATIONS 17

- Electronics Technology
- Mechanical Technology
- Electro-Mechanical Technology
- Civil Technology

PART IV - CONCLUSIONS AND RECOMMENDATIONS 108

APPENDICES 112

- I Project Information
- II Articulation Information
- III Unified Physics
- IV Remedial Courses
- V Comments From Industry
- VI Community Colleges - Respondents

PART I - INTRODUCTION

A. DEFINITIONAL PROBLEMS IN TECHNICAL EDUCATION

Terms such as "occupational education", "vocational education", "technical education", and "career education" have been used (and misused) to classify a wide variety of similar and dissimilar educational programs. In this publication, the term "technical education" refers to educational programs in some particular field or discipline that are related to engineering and are occupationally oriented.

What is a technician? An engineering technician? An industrial technician? What are the identifying characteristics of an Engineering Technology curriculum--an Industrial Technology curriculum? These questions have been asked repeatedly and are the main issues addressed in this curriculum guide; moreover, California Community Colleges should become seriously involved in an attempt to establish the answers in order to provide greater significance and uniformity to the terminology used to identify the programs offered by community colleges.

Reference may be made to definitions provided by national societies and organizations or by various government agencies:

The U.S. Bureau of Labor Statistics (BLS), BLS Bulletin 1512, defines technicians as

> "...workers who directly or indirectly support scientists and engineers in designing, developing, producing, and maintaining the Nation's machines and materials."

National Science Foundation (NSF), Report NSF 63-64, defines technicians broadly as

> "...all persons engaged in work requiring knowledge of physical, life, engineering and mathematical sciences comparable to the knowledge acquired through technical institute, junior college, or other formal post-high school training or through equivalent on-the-job training or experience."

Engineers Council for Professional Development (ECPD) 42nd Annual Report, definition reads as follows:

> "Engineering Technology is that part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer."

In the Engineering Technology Education Study, Final Report--American Society for Engineering Education Journal, Jan. 1972, the following definition is given:

> "Engineering Technology is that part of the engineering field which requires that application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the occupational area between the craftsman and the engineer at the end of the area closest to the engineer."

> "Engineering Technology is concerned primarily with the application of established scientific and engineering knowledge and methods. Normally engineering technology is not concerned with development of new principles and methods. Technical skills such as drafting are characteristic of engineering technology."

Several definitions of Industrial Technology are listed below. It is important to note that the sources quoted are addressed to the four-year baccalaureate programs. There appears to be no defining literature available for two-year associate degree occupational programs in Industrial Technology.

The California State Colleges Study "Industrial Arts/Industrial Technology", 1970 (sometimes referred to as the "Banister Report") includes the following:

> "The graduate, though having knowledge of basic industrial skills, is oriented towards assisting and directing the development program, the flow of production, the distribution of the product and other facets of general management. The [Industrial] technologist supervises operations involved in the development of a consumer product, or its movement to the distribution point, and even making it acceptable and popular on the open market. Some curricula offer variations in the business portion, permitting a sales emphasis, for example."

The California Council on Industrial Arts Teacher Education submitted the following remarks on Industrial Technology in a "position paper" (1968):

> "...preparing students for such positions as those in planning, supply, product utilization and evaluation, production supervision, management, marketing research, and technical sales."

The National Association of Industrial Technology (NAIT) is presently recognized as the accrediting agency for baccalaureate degree programs in Industrial Technology. NAIT provides the following definition:

> "The Curriculum, even though built on technical education, has a balanced program of studies drawn from a variety of disciplines drawn from industry. Included are a sound knowledge and understanding of materials and manufacturing processes, principles of distribution, and concepts of industrial management and human relations; experience in communication skills, humanities, and social sciences; mathematics, design, and technical skills to permit the graduate to capably cope with technical, managerial and production problems."

The reader is again reminded that the foregoing definitions refer to the four-year programs in Industrial Technology. Considering the fact that a large number of community colleges offer occupationally oriented two-year Industrial Technology programs, it is important to establish a proper identity and definition for these curriculums.

Moreover, it is essential to distinguish the identity of these occupationally oriented two-year programs from the lower-division curriculums designed to prepare the student to matriculate into a baccalaureate program in industrial technology (BIT).

In order to evaluate a curriculum, it is essential that the educational objective be defined and a quality standard of instruction be established. It is fundamental that a program be properly identified as either Trade and Industry, Industrial Technology, or Engineering Technology. Each program has unique values both to students and employers; therefore, it should be advantageous and reasonable to accurately designate the program classification in accordance with some standard criteria. A principle objective of this project is to assist community colleges in this task.

B. PROJECT GOALS

This publication is intended to provide a communication device for community college districts and campuses. The goals of the project are as follows:

1. Establish the fundamental requirements and identify the similarities and differences which distinguish Engineering Technology, Industrial Technology, and Trade and Industry programs.
2. Develop descriptions and designations for engineering technology and industrial technology curriculums.
3. Develop minimum content requirements for engineering technology and industrial technology curriculums in the following discipline areas--Civil, Electronics, Electro-Mechanical, and Mechanical. These curriculums will illustrate the particular differences in engineering technology and industrial technology programs. Although this project is restricted to the four disciplines cited above, other studies should be considered to include other curriculums.
4. Obtain a consensus from the California Community Colleges on the developed minimum program requirements, curriculum requirements, and curriculum descriptions and designations.
5. Prepare a California Community College guide that will allow for the evaluation of current programs and the opportunity to revise curriculums and/or curriculum designations and descriptions where needed.

C. SCOPE

The primary purpose of this publication is to identify and define the distinguishing characteristics of programs in technical education which lie between the traditional "Trade and Industry" curriculums and the baccalaureate degree "Technologist" curriculums offered by State Universities and private colleges and institutes. The content presented here is based upon the following qualifications:

1. The curriculums are limited to "engineering/industrial related" disciplines--specifically in the fields of civil, electronics, electro-mechanical, and mechanical.
2. The primary objective of the course of study is to qualify

the student for employment opportunities and for career advancement; however, certain curriculums also may well provide the opportunity for advanced training or for matriculation into baccalaureate degree programs.

3. Community colleges are uniquely qualified to provide this type of technical education.
4. It is desirable that California Community Colleges establish more uniform core curriculums in specific discipline areas--both in content and identity. It is not the intent to establish complete commonality; indeed, such factors as geographic location, demographic characteristics, enrollment characteristics, and resources will necessarily cause some differences in program offerings. There is substantial evidence, however, that a greater degree of uniformity is possible and desirable. For example, consider the advantages which would accrue to students who wish to transfer from one community college to another, or to a four-year college or university to continue their education in a baccalaureate degree program in engineering technology (BET) or in industrial technology (BIT). Also consider the advantages graduates would receive if industry could establish job classifications based upon comparatively uniform curriculum content; moreover, industry would know the capabilities of the graduates from these curriculums. This knowledge would enable industry to recruit a greater number of technicians from California Community Colleges and lessen the need for expensive recruiting activities outside of California. Furthermore, community college faculty and administrators would be able to communicate more effectively about technical education programs without having to learn another language--the one used by the neighboring community college. These appear to be commendable objectives which should encourage a greater degree of uniformity among technical education programs.

In order to stimulate communications, two basic vehicles must be established at the outset: (a) the spectrum of technical education must be identified, and (b) the educational areas within the spectrum must be categorized. Part II of this report will deal with this topic.

D. SUMMARY OF PROCEDURES

Having established the need for the project, the project director's first step was to contact all California Community Colleges. This initial correspondence had three objectives: to inform the reader of the purpose of the project, to request a contact designate to participate in providing information for the project, and to solicit recommendations for members of a statewide advisory committee that would work with the project director in developing project material.

A statewide advisory committee of twelve members was established. The committee was selected to provide representation of community colleges with small to large enrollments and to provide geographic representation throughout the State--from San Diego to Redding.

The Statewide Advisory Committee was responsible for assisting the project director in gathering and validating information, analysing data, and reviewing all draft material for the project publication. The Committee met five times during the period from April 1974 to October 1975. In addition, sub-committees met to review curriculum material related to specific disciplines, and representatives from the Committee participated in an Industry-Education Workshop. The publication draft was thoroughly reviewed during a two-day meeting in October 1975.

The project director visited 25 community colleges, five State Universities, and eight industrial firms to gather data for the project. A sample of seventy-two community colleges participated actively in the compilation of information for the project.

Two questionnaires were used as survey instruments to develop data regarding existing programs in engineering technology and industrial technology currently being offered by community colleges.

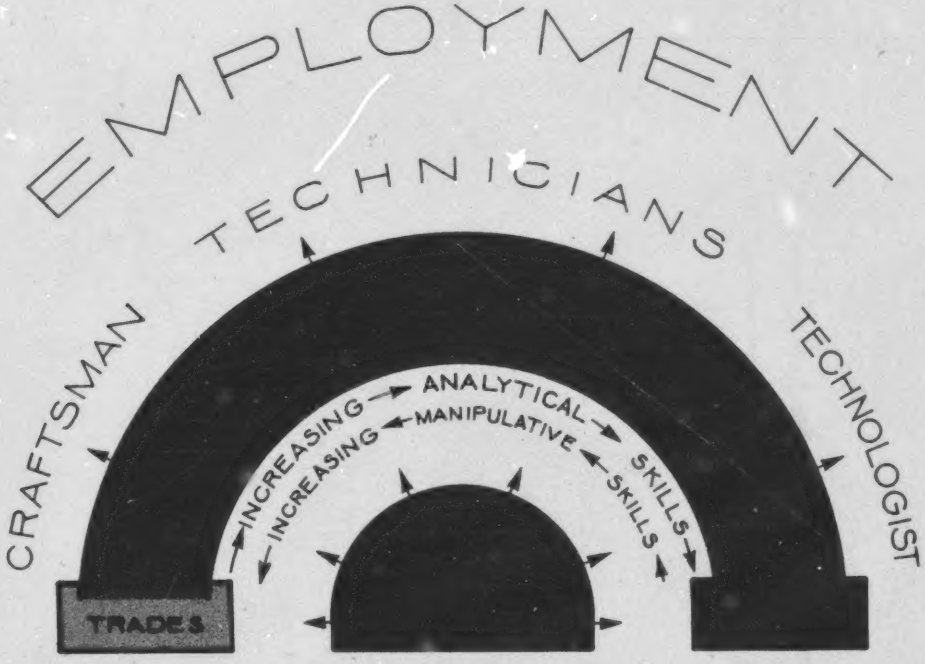
An Industry-Education Workshop was held in December 1975. The purpose of the workshop was to provide an opportunity for formal input from industry to review the publication draft and evaluate the curriculum content in terms of employment qualifications.

A more detailed account of project information is included in Appendix I.

PART II - CLASSIFICATION GUIDELINES

A. TECHNICAL EDUCATION SPECTRUM

Technical education bridges the spectrum of technical-occupational programs, including the trades (apprenticeship training) on one end--to the professional engineer on the other. Figure 1 illustrates this spectrum. The figure is not a flow-diagram; rather, it illustrates the interface of the educational program and the rigor and content of the curriculum in terms of "increasing analytical skills" (mathematics and science) and "increasing manipulative skills". It should be noted that the program categories are overlapping rather than a series of isolated, discrete entities; moreover, industry emphasizes that work assignments also blur the interfacial boundries.



EMPLOYMENT
TECHNICIANS
CRAFTSMAN
TECHNOLOGIST
INCREASING ANALYTICAL SKILLS
INCREASING MANIPULATIVE SKILLS
TRADES

FIGURE 1
EDUCATIONAL/EMPLOYMENT SPECTRUM OF TECHNICAL EDUCATION

Inasmuch as this publication is addressed to community college programs classified as engineering technology (ET) and industrial technology (IT), the central area of the spectrum is of primary significance. The following discussion is appropriate to establish the boundary conditions of the (ET)/(IT) classifications.

B. (ET)/(IT) BOUNDRY IDENTITIES

Trade and Industry: The content of these curriculums is heavily oriented towards manipulative skills required by mechanics and craftsmen. Frequently these are certificate programs consisting of less than two years of course work. They are often associated with apprenticeship programs; however, the associate degree curriculums usually afford the graduate greater opportunities for career advancement. In general, there are no specific required mathematics or science courses. The necessary mathematics is integrated into the technical course work. Formal curriculum prerequisites are not generally prescribed.

Bachelor of Engineering Technology: This emerging program, an extension of the two-year (ET) programs, is offered by several State universities and independent colleges and institutes. The following definition developed by the Engineers Council for Professional Development is applicable to both two- and four-year curriculums.

> Engineering Technology is that part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer.

The baccalaureate degree (engineering technologist) program offers greater depth in mathematics and sciences, and greater breadth, than that of the associate degree (engineering technician) program.

Bachelor of Industrial Technology: This program generally evolved within departments of industrial arts education where some continue, but others have independent existence in any one of several colleges in the State University system. The following description published by California Polytechnic State University is generally representative of the program objectives:

> ...prepare graduates for employment in a broad range of professional positions in industrial management, industrial production, industrial marketing or industrial and public education. For those interested in industry the course offerings qualify students for occupations in the mid-ground between engineering and business.

It is difficult to correlate the industrial technology programs in state universities with the (IT) program in community colleges because of the diversity of the curriculums and curriculum objectives of community college programs. However, the graduate of the State University is identified as an industrial technologist while the community college graduate is classified as an industrial technician. This publication is addressed to the classifications of educational programs which interface with (and overlap somewhat) the boundry programs outlined above.

C. ENGINEERING TECHNOLOGY AND INDUSTRIAL TECHNOLOGY

Within the community college system, a broad definition for (ET) and (IT) classification may be stated as follows:

Engineering Technology comprises those curriculums that prepare a person for employment (as an engineering technician) who is in direct support of an engineer--and/or those curriculums that serve as lower division preparation for matriculation to a four year baccalaureate degree program normally in engineering technology. The graduate may also opt for other kinds of advanced training.

> "The programs in Engineering Technology...have a wide range of objectives but have a common purpose of preparing students for immediate usefulness in technical employment. Programs are technological in nature with instruction offered in the broad area of technical education at levels between engineering and vocational education--industrial technology." (1)

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(1) Engineers' Council for Professional Development, ECPD, 42nd Annual Report, Pg. 45.

Industrial Technology comprises those curriculums that prepare a person for employment (as an industrial technician) in production, service, construction, or related fields. These curriculums have generally evolved from the inclusion of a greater amount of mathematical and technical subject matter than that found in the traditional Trade and Industry curriculums. Generally, industrial technology curriculums provide additional opportunities for career advancement beyond those afforded graduates of Trade and Industry curriculums; however, entry level employment may be quite similar.

The programs discussed in this publication are primarily occupationally oriented and do not represent the recommended lower-division course work for the (BIT). However, some community colleges do indeed offer a lower-division program for the (BIT).

The two classifications, (ET) and (IT), overlap, as illustrated in Figure 2. This publication will define and describe the median areas of the classifications which are most representative.

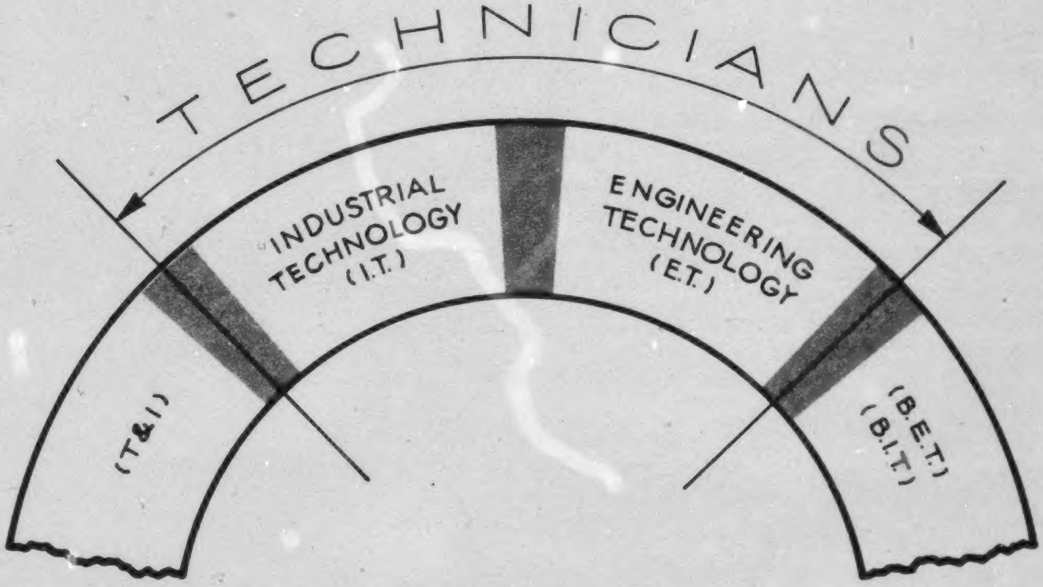

FIGURE 2
ENGINEERING TECHNOLOGY AND INDUSTRIAL TECHNOLOGY

A method of further delineating the (ET)/(IT) classification is a comparative outline of the distinguishing characteristics in six general areas of the educational program: Computational Skills, Physical Sciences, Communication Skills, Primary Technical Skills, Related Technical Skills, and General Education.

The curriculum which includes the characteristics outlined below should provide adequate training for job entry and a fundamental education for career advancement. In addition, the curriculum should satisfy the requirements for the associate degree (AA or AS) in two years of normal work, provided the student's high school background included the necessary matriculation work.

D. (ET)/(IT) CURRICULUM STRUCTURE CHARACTERISTICS[1]

1. COMPUTATIONAL SKILLS[2]

Engineering Technology	Industrial Technology
Requires proficiency in the analytical use of mathematics, including algebra, geometry, trigonometry. (An introduction to analytical geometry and the calculus is recommended for some curriculums.) Emphasis should be on application and problem-solving, with minimal treatment of derivations and theory.	Requires competence in the application of arithmetic, elementary algebra, and basic right angle trigonometry to solve typical problems associated with the technical discipline of the curriculum.
For example: a) The use of modern computational devices, (calculators...).	For example: a) Arithmetic operations, including fractions, decimals, percentages, and ratios.

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[1] It is recognized that certain topics, listed or not, may be more or less emphasized depending upon the curriculum discipline.

[2] The topics listed are based upon the following minimum curriculum prerequisite requirements:

a) For Engineering Technology curriculum:
Intermediate algebra or equivalent.

b) For Industrial Technology curriculum:
One semester of high school general mathematics. Certain topics listed may be integrated into the curriculum technical course work rather than in discrete "mathematics" course(s).

Engineering Technology

b) Algebraic operations to include:
   1. Ratios and proportions.
   2. First and second order equations in both one and two variables.
   3. Exponentials and their relationship to logarithms.
   4. Graphical methods of processing, and interpretation of data.
   5. Introduction to determinants.

c) Trigonometric operations to include:
   1. Right and oblique triangles.
   2. Applications of trigonometry to periodic phenomena (oscillations, etc.).
   3. Relationship of degree/minutes/seconds to radians.

d) Analytic geometry and calculus to include:
   1. Coordinate systems.
   2. Equation of lines.
   3. Analytical and graphical treatment of the significance of slope.
   4. Significance of first and second derivatives.
   5. Maxima and minima.
   6. Integration by formula and graphical methods.

e) Statistics and/or other instruction in mathematics.

Industrial Technology

b) Algebraic operations to include:
   1. Solution of first order equations for one unknown variable.
   2. Simultaneous solution of two equations for two variables.

c) Trigonometric operations to include:
   1. Solution of right triangles. Sine, cosine, and tangent relationships--use of tables (slide rule and/or calculators).

2. PHYSICAL SCIENCES

Engineering Technology

Requires an understanding of, and the ability to apply, the concepts of physics, chemistry, and other physical sciences appropriate to the technical discipline and commensurate with the level of mathematical skills as in (1) above.

Industrial Technology

Requires the ability to use concepts of physics and other physical sciences appropriate to solve problems related to the technical discipline of the curriculum and commensurate with the mathematical skills specified in (1) above.

Engineering Technology	Industrial Technology
For example:	For example:
a) Chemistry to include:(1) 1. Simple atomic structure. 2. Acid-base relationship, including pH. 3. Oxidation-reduction as pertains to: Corrosion and galvanic protection Electrolysis Simple galvanic cells 4. Properties of materials as related to: Periodic table Types of bonds Geometry of molecules 5. Elementary organic chemistry.	a) Chemistry: Integrated into technical course work as required by curriculum discipline.
b) Physics to include: The following concepts and parameters, as they apply to electrical, fluid, mechanical, and thermal systems: 1. Differential force 2. Flow rate 3. Static and dynamic energy storage 4. Time constant 5. Resistance 6. Waves and fields	b) A course equivalent to high school physics or comparable content (as required) included in technical course work.

3. TECHNICAL SKILLS

Engineering Technology	Industrial Technology
Requires proficiency in analytical and manipulative skills requisite to the broad support requirements of the engineer and other technical personnel in the related technical disciplines such as: data acquisition and analysis; design; testing, evaluating and troubleshooting. Should be capable of performing these activities with minimal supervision; indeed, the skilled engineering	Requires a higher degree of proficiency in manipulative skills than the engineering technician and some analytical skills in order to perform typical job activities such as: installation, inspection, fabrication or construction, and routine maintenance and repairs within the purvue of the curriculum discipline. May perform more sophisticated job activ-

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(1) May be satisfied by a year course in high school chemistry.

Engineering Technology	Industrial Technology
technician, with experience, will frequently be required to assume full responsibility as an individual.	ities under adequate supervision.

4. COMMUNICATION SKILLS

Engineering Technology	Industrial Technology
Should be able to prepare, interpret, and transmit technical information acquired by and for the engineer and other technical and management personnel utilizing the oral, written, computer, and graphic language of the discipline.	Should be able to communicate orally and read with understanding (comprehension). Should be thoroughly familiar with the graphic language used in the occupational field of the curriculum. May be required to participate in the written reports.

5. RELATED TECHNICAL SKILLS

Engineering Technology	Industrial Technology
Should acquire other skills as required to enable the engineering technician to work and communicate and interact with both subordinates and superiors. Should be knowledgable about the principles of practical economics, environmental requirements, and safety aspects pertinent to the engineering discipline.	Should acquire other skills to enable the industrial technician to communicate and interact with his fellow employees and management. Should be aware of basic economic and environmental implications, and thoroughly familiar with the safety aspects, related to the curriculum discipline.

6. GENERAL EDUCATION

Engineering Technology	Industrial Technology
To provide opportunities for the students to acquire and develop intellectual and ethical competencies which may provide consciousness and social growth so that they may participate as responsible citizens in our society.	To provide opportunities for the students to acquire and develop intellectual and ethical competencies which may provide consciousness and social growth so that they may participate as responsible citizens in our society.

Several important considerations should be emphasized from the above outline. The following are particularly noteworthy:

1. The general distinguishing characteristic which catagorizes the two types of technician education programs is the

difference in the degree of emphasis on analytical skills (mathematics and science) and manipulative skills. The kind of employment for which the graduates may qualify is related to this difference in emphasis. This point will be developed in greater detail in Part III of this publication.

2. There is a degree of commonality in the two program types--particularly in the technical skills area. This similarity can provide some mobility between the two programs; however, the degree of mobility will depend upon the discipline and structure of the curriculums.

3. Both programs are designed to provide opportunity for employment. The engineering technology curriculums may also satisfy the requirements for matriculations toward a baccalaureate degree in engineering technology (and in some cases in industrial technology) without significant loss of time. However, the program in industrial technology is not intended to represent the lower-division requirements of the baccalaureate degree in industrial technology. This (IT) curriculum outline is specifically designed to provide an educational program for industrial technicians.[1]

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[1] For information concerning articulation with baccalaureate degree (BET and BIT) programs, see Appendix II.

PART III - CURRICULUM RECOMMENDATIONS

The presentation in the preceeding sections provided the identity and definition of engineering technology and industrial technology and outlined fundamental characteristics of the two programs. The curriculum information and recommendations which follow are based upon the frame of reference developed in Parts I and II.

It should be apparent that the task of developing a curriculum guide is an extremely complex undertaking. The large number of variables which must be considered are somewhat overwhelming. However, two primary criteria can be cited from which the essential ingredients may be derived: (1) The recommendations should challenge a college to offer a curriculum which will provide optimum value to the student, industry, and the community in general; and (2) the guide must provide realistic and practical information so that the curriculum can indeed be offered by the community college. These criteria require careful consideration of every entity and certainly some degree of compromise.

Both (ET) and (IT) curriculum recommendations are included for Electronics Technology and Mechanical Technology. No recommendations are submitted for industrial technology curriculums in Civil or Electro-Mechanical at this time. The reasons for not including (IT) curriculums in these disciplines are: (a) there does not appear to be a significant employment market for a civil technician with the minimal skills which could be developed in an industrial-technology type program, and (b) the academic requirements for success in an electro-mechanical curriculum involves a degree of analytical proficiency greater than that which is commensurate with the typical industrial technician.

The curriculum prerequisites warrant some special comments. In most cases two entries are submitted; namely, a recommended prerequisite and a minimum prerequisite. This practice is employed to accomodate the differences in conditions which influence the way in which community colleges must offer occupational programs. In general, the recommended prerequisite will allow an opportunity to provide a greater amount of depth in the technical course work. On the other hand, the minimum prerequisite is intended to accommodate entering students having fewer courses completed in high school mathematics and science.

Each community college should adopt the technical education program most suited to the needs, capabilities, and occupational objectives of its students. Therefore, the curriculum prerequisite--and hence the curriculum structure--ought to be selected to provide the opportunity for maximum educational and occupational achievement for the students. It is suggested that this can best be accomplished by offering curriculums in both engineering technology and industrial technology if it is economically feasible to do so. In the decision making process it is essential to consult with industry representatives to ensure that the curriculum content will develop salable skills for the graduates at the job entry level and for career advancement.

In addition to the two-year curriculums, some short-term certificate programs are listed. These include a few sample programs and are not intended to be all-inclusive.

With regard to the course descriptions, the designated prerequisites indicate the level and rigor of the material included in the course content. The course numbers were not "borrowed" from any known community college, they were improvised for the purpose of this publication according to the following plan: technical courses in the first year core recommendations are numbered 11 - 19; second year courses are numbered 21 - 29; technical electives are designated by numbers 110 -. An exception to this plan occurs when a core course from one curriculum is recommended as a technical elective for another curriculum. The semester unit value and arrangement of hours (lecture, laboratory, etc.) are recommended as typical, not mandatory. It is acknowledged that local conditions may dictate some rearrangement of the structure of the courses and/or curriculum format; however, it is particularly important that careful consideration be given to sustain the overall educational package established by the core curriculum.

Several representatives from industry who received the publication draft recommended that the course descriptions should be expanded to more fully identify the course content and level of instruction. In compliance with these suggestions, many course descriptions were expanded and revised; in addition, typical performance objectives are included, for most courses, to supplement the course description. It should be apparent that the listed performance objectives are not all-inclusive, rather, the information is designed to help the reader identify some typical capabilities of students who successfully complete the course.

The array of mathematics courses included in the guide is an indication of the degree of flexibility intended in framing the core curriculums. It will be noted that six mathematics courses, representing four levels of competency, are included for the curriculums presented on the following pages. The level of mathematical competence may be achieved by offering discrete courses in the subject or by the integration of mathematics into the technical course work. Each technique has certain advantages and disadvantages. Discrete courses will generally ensure the development of more uniform and identifiable mathematical competence. This is an important factor in the evaluation of the curriculum by industry, or for matriculation or articulation purposes. However, the technique of integrating the instruction in mathematics into technical course work will, in general, provide an advantage in motivating the student to better understand, apply, and retain the mathematical concepts.

The recommended structure of the mathematics courses provides the opportunity of including the advantages of both techniques outlined above. The scheduled lectures afford the accountability of mathematics content and rigor while the problem-solving sessions can motivate the student and stimulate retention by direct association of the mathematical concepts with the technical requirements of the curriculum discipline.

The unit values for all courses are expressed in semester units.

ELECTRONICS TECHNOLOGY

This section will include course and curriculum recommendations for Electronics Engineering Technology, Electronics Industrial Technology, and certificate programs in electronics.

A. GENERAL REMARKS--EDUCATIONAL OBJECTIVES

B. ELECTRONICS ENGINEERING TECHNOLOGY
    1) Curriculum Prerequisite
    2) Core Curriculum (Suggested Sequence)
    3) Technical Electives
    4) Course Descriptions
    5) Employment Opportunities

C. ELECTRONICS INDUSTRIAL TECHNOLOGY
    1) Curriculum Prerequisite
    2) Core Curriculum (Suggested Sequence)
    3) Technical Electives
    4) Course Descriptions
    5) Employment Opportunities

D. CERTIFICATE PROGRAMS

A. GENERAL REMARKS - EDUCATIONAL OBJECTIVES

The tremendous demand for electronics technicians during the past two decades provided ample motivation for the large number of programs offered by community colleges in this discipline area. The enrollment in electronics programs is considerably greater than that in other technical education programs.

Many important recommendations which were submitted by the participants of the Industry-Education Workshop, and by other individuals who reviewed the draft copy, have been included in the curriculum and course information which follows. One particular point which should be emphasized is that of providing adequate opportunity for mobility between the EET and EIT curriculums. This provision would allow students to explore alternate academic pursuits to find the kind of employment preparation most suitable to their interests and capabilities. With this objective in mind, it is recommended that the courses in the two curriculums (particularly the first year) be analysed to identify possible transfer of course credit between the two curriculums. For example, a student who has completed EIT 11 and EIT 13 might be allowed credit for EET 11 and EET 11L. Transfer of credit would depend upon the structure, content, and rigor of the courses; therefore, the specific certification of comparable achievement would vary somewhat among community colleges.

Two frequent recommendations were that the student should develop "an appreciation for a systems approach" and that there should be a strong "emphasis on troubleshooting" in the curriculum. These recommendations should be given serious consideration when specific course content and methodology are established.

The primary educational objective for the curriculums outlined in the following material is to provide adequate knowledge and skills for employment, at various entry levels, and for career advancement as electronics technicians. Specific employment qualifications will be included in the sections dealing with the particular curriculum. The curriculum in Electronics Engineering Technology will also provide matriculation opportunities to those students who wish to continue their education in either the (BET) or (BIT) programs.[1]

B. ELECTRONICS ENGINEERING TECHNOLOGY

1. CURRICULUM PREREQUISITE

The recommended curriculum prerequisite is satisfactory completion of high school trigonometry (or equivalent) and a course in mechanical drawing.

The minimum prerequisite is intermediate algebra (equivalent competency in algebra) and high school mechanical drawing.

In addition, a desirable supplement for either prerequisite cited above would include a course in high school general science or physics.

2. CORE CURRICULUM (SUGGESTED SEQUENCE)

The following outline and suggested sequence of courses is based upon the minimum curriculum prerequisite. [illegible] the recommended curriculum prerequisite is adopted, the first semester course in mathematics may be reduced by one unit and instruction in mathematics in the technical courses may be minimized. The additional time thus gained may be used to provide greater in depth instruction in the technical courses. Descriptions of typical remedial courses are included in Appendix IV. These courses are designed to allow the student to remove high school deficiencies and thereby satisfy the recommended curriculum prerequisite.

Students who satisfactorily complete this curriculum will be well qualified for employment as electronics engineering technicians. Moreover, successful completion of the core curriculum and suitable electives will satisfy the articulation requirements for the BET degree program.

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[1] Refer to Appendix II.

ELECTRONIC ENGINEERING TECHNOLOGY

(AS Degree Curriculum)

Suggested Sequence

First Semester:

EET 11	AC-DC Passive Circuits Analysis	5
EET 11L	AC-DC Passive Circuits Laboratory	2
Math 1E	Mathematics for Electronics	4
Tech. Engl. 1	Communications Skills & Report Writing	3
Technology 10	Occupational Safety & Health	2

Second Semester:

EET 12	Basic Electronic Devices & Circuits	5
EET 12L	Basic Active Circuits & Devices Laboratory	2
EET 13	Introduction to Digital Electronics	3
(1)Math 2E	Advanced Mathematics for Electronics	3
Physics 1	Technical Physics	3

Third Semester:

Drafting 1E	Graphics for Electronics	3
EET 21	Advanced Electronic Circuits	3
EET 21L	Advanced Electronic Circuits Laboratory	2
*Electives		

Fourth Semester:

EET 22	Pulse and Switching Circuits	3
Technology 20	Human and Industrial Relations	2
*Electives		

*Electives should be selected to fulfill graduation requirements and provide technical elective courses. A minimum of 15 units of technical elective courses should be selected by the student in consultation with the Curriculum Technical Advisor, or Counselor, to fulfill the educational requirements of the student's selected speciality or option. At least one systems oriented course should be included.

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(1) Math 2 may be substituted for Math 2E.

3. TECHNICAL ELECTIVES

A study of employment classifications for electronics engineering technicians suggests four areas of specialization (options): (a) Computer Electronics, (b) Communications, (c) Instrumentation and Testing, and (d) Research--Prototype Development.

The option (b) undoubtedly needs additional definition. This "umbrella" title would include radio, radio-telephone, television, microwave, etc. However, there is a thread of commonality--the program coordinator should decide on the emphasis according to the employment potential afforded the students in the program. It is acknowledged that the specific topic emphasis and methodology used in the core courses will influence the treatment of the recommended content of the technical elective courses.

The following list of courses is submitted to indicate the type of knowledge and skills which should be developed to provide reasonable proficiency in the specialty employment area. The letters in brackets [a,b,c,d] in the right margin relate the course value to the options noted above. The assigned unit values are typical.

Computers 1	Programming Techniques (3)	[a,b,c,d]
EET 110	Electronic Systems Analysis (4)	[b,c,d]
EET 120	Computer Electronics (5)	[a,d]
EET 130	Microwave Theory & Measurements (4)	[b,c]
EET 140	Advanced Electronic Communication Systems (3)	[b,c,d]
EET 150	Electronic Fault Diagnosis (2)	[a,b,c,d]
EMT 23	Electromechanical Controls, Devices & Systems (4)	[a,c,d]
EET 200	Special Projects (2-4)	[a,b,c,d]
EET 300	Work Experience	
EIT 12A	Fabrication Techniques (2)	[b,c,d]
EIT 12B	Advanced Fabrication Techniques (3)	[b,d]

4. COURSE DESCRIPTIONS[1]

(CORE CURRICULUM COURSES)

EET 11 AC-DC Passive Circuit Analysis (5)

5 hours lecture
Prerequisite: Mathematics 1E and EET 11L must be taken concurrently.

Principles of direct- and alternating-current circuits. Emphasis on network theory and passive network analysis; study of the circuit action of significant combinations of resistance, capacitance, and inductance.

1. Design a RC series circuit that will result in a given voltage across the capacitor at a specified time after the DC circuit potential is applied.
2. Given three required voltages and their respective currents, design a voltage divider network for a given bleeder current and power supply potential.
3. Given values of inductance, capacitance and resistance for a parallel circuit, determine the total current for a given supply voltage of known frequency.

EET 11L AC-DC Passive Circuits Laboratory (2)

6 hours laboratory
Prerequisite: Concurrent enrollment in EET 11

Laboratory exercises in direct- and alternating-current circuits; the use of basic electronic measuring instruments, tools, and components to familiarize the student with fundamental test and measurement techniques.

1. Given an inductor and capacitor of unknown values, determine experimentally the parallel resonant frequency and the bandwidth of the circuit.
2. Given an oscilloscope with calibrated vertical and horizontal deflection, determine the effective voltage and frequency of an unknown sine wave.

EET 12 Basic Electronic Devices and Circuits (5)

5 hours lecture
Prequisite: EET 11 (or equivalent) and Math 2E (Math 2E may be taken concurrently)

Study of the fundamental characteristics of active devices;

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[1] See Appendix IV for matriculation (remedial) courses.

transistors, rectifiers, diodes, biasing techniques; Class A amplifiers.

1. Given a Class A amplifier circuit with a given load resistance and a transistor with known beta, specify correct values of the biasing resistors.
2. Specify the resistance values and power ratings of a simple zener regulator circuit when given supply and load potentials and the load current variation.

EET 12L Basic Active Circuits and Devices Laboratory (2)

6 hours laboratory
Prerequisite: Concurrent enrollment in EET 12

Laboratory exercises in active circuits and devices; use of electronic measuring equipment is stressed.

1. Given a bipolar transistor and an ohmmeter, determine if the transistor is NPN or PNP type and if it is open, shorted, or good.
2. Using a transistor curve tracer, determine the beta and collector breakdown voltage of a transistor.
3. Determine the phase shift of a signal through a network by the use of a dual-trace oscilloscope.

EET 13 Introduction to Digital Electronics (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EET 11 and EET 11L

Theory and measurements of digital and logic circuits, operational amplifiers, and analog/digital circuits and systems; emphasis is on integrated circuits.

1. Given a diagram consisting of AND gates, OR gates and inverters, draw a truth table.
2. Design and construct an astable multivibrator using bipolar transistors for a given frequency.
3. Using J-K flip-flops, build a modulo six counter and analyse its operation using appropriate test equipment.

EET 21 Advanced Electronic Circuits (3)

3 hours lecture
Prerequisite: EET 12 and EET 12L

Advanced study in linear and nonlinear circuits; amplifiers, oscillators, multivibrators and modulators; high-frequency instrumentation and measuring techniques.

1. Given the efficiencies and power inputs to both the modulator and final amplifier of a high-level-modulated transmitter, determine the power in the carrier and each sideband.

2. Given the schematic of a single stage amplifier and the characteristic curves of the active device, analyze the circuit through the use of load lines.

EET 21L Advanced Electronic Circuits Laboratory (2)

6 hours laboratory
Prerequisite: Concurrent enrollment in EET 21

Laboratory exercises involving electronic circuit responses to various types of input signals as discussed and developed in the lecture material. Measurement and testing techniques are stressed.

1. Use an oscilloscope to determine the percent modulation of an amplitude modulated signal.
2. Given a transmission line with signal and appropriate test equipment, determine the frequency and VSWR.
3. Given an amplifier and appropriate test equipment, determine the frequency response and gain.

EET 22 Pulse and Switching Circuits (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EET 13 and EET 21 (EET 21 may be taken concurrently)

Study of non-sinusoidal circuits; transient circuits, waveform analysis, synthesis of solid state multivibrator, blocking oscillator and time-base generators circuits; emphasis on high-speed measurement techniques. Laboratory practice and procedures in use of measurement and test instruments and accessories.

1. Given a repetitive pulse signal and an oscilloscope, determine the risetime, falltime, pulse width, prf and duty factor.
2. Design a unijunction oscillator circuit for a given frequency.
3. Through the use of pulse techniques and appropriate equipment, determine the position of a fault on a transmission line.

Drafting 1E Graphics for Electronics (3)

6 hour lecture - laboratory
Prerequisite: One year high school drawing or equivalent

Practice in preparation and interpretation of block diagrams, schematic diagrams, pictorials, and introduction to the use of drawing systems and standards such as American National

Standards Institute, National Electrical Code and Military Standards in the preparation and interpretation of interconnection and wiring diagrams, commercial and industrial wiring, and fundamentals of printed circuit board design.

1. Lay out the design of a printed circuit board from a simple schematic.
2. Given a chassis containing a simple circuit, draw the circuit schematic in accordance with the standards established by the American National Standards Institute.

Math 1E. Mathematics for Electronics (4)

3 hours lecture, 2 hours problem-solving session
Prerequisite: Intermediate algebra (Mathematics A or equivalent is recommended); or Math IT-1 with permission of instructor

Fundamentals of trigonometry. Instruction in mathematics applied to the study of alternating current circuitry with emphasis on periodic functions, vector and phasor analysis and logarithms. Use of calculators and other computational devices.

Theory, problem-solving techniques, and general applications are presented in the lectures; treatment of specific problems in concurrent technical course work and other typical problems in electronics are included in the problem-solving sessions.

1. Given two of the three quantities (power in, power out, and gain or loss in decibels), calculate the third.
2. Given a series-parallel RLC circuit with sufficient information, use phasors and complex numbers to solve for any unknown value of voltage or current.

(1)Math 2E. Advanced Mathematics for Electronics (3)

2 hours lecture, 2 hours problem-solving session
Prerequisite: Math 1E; or Math 1 with permission of instructor

Instruction in the basic concepts of differential and integral calculus; emphasis is on applications to problems encountered by the electronics engineering technician.

Theory, techniques, and general applications are presented in the lectures; specific applications and problem-solving procedures and techniques are included in the problem solving sessions.

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(1)For description of alternate course (Math. 2), see page 59.

(Note: The objective of this course is to familiarize the student with the application of these mathematical tools and develop greater proficiency in the use of algebra and trigonometry and problem-solving techniques and procedures.)

1. Given an expression for current as a function of time, use calculus to solve for critical values of time and determine if the current is a maximum or minimum.
2. Given an expression for the potential across a capacitor, use calculus to solve for the current.
3. Given an expression for the current through a capacitor of known value, use calculus to solve for the potential at any time.

Physics 1 Technical Physics (3)

2 hours lecture, 3 hours laboratory
Prerequisite: Mathematics A and Physics A (or equivalent); Mathematics 1 or 1E is recommended, may be taken concurrently

Lectures, demonstrations, and laboratory exercises in the fundamental concepts of mechanics, electricity, fluids, and heat. (Refer to Physics 11, page 90, for an alternative course--"Unified Physics").

1. Experimentally determine the natural resonant frequency of a mechanical system consisting of a mass and a spring.
2. Given a circuit containing resistors and capacitors connected to a D.C. source, determine the energy stored in each capacitor.

Technical English 1 Communication Skills and Report Writing (3)

2 hours lecture, 2 hours laboratory - conference
Prerequisite: Qualifying score on English placement test

Instruction and practice in communication of both oral and written information. Emphasis on techniques for writing various types of technical communication and reports. Assistance with the writing of laboratory reports is provided during the laboratory-conference sessions.

1. List and describe the three frames of reference from which a mechanism, or electronic device, may be described.
2. Write a suitable topic sentence (generalization) which can be developed by five or more supportive statements, joined coherently.

3. Plan and write a report based on experimental data collected in a laboratory course; also prepare an outline and deliver an oral presentation on the report subject.

Technology 10 Occupational Safety and Health (2)

2 hours lecture
Prerequisite: None

Employer and employee responsibility, Federal and State legislation, accident reports, industrial hygiene, personal protective equipment, materials handling and storage, guarding machines and mechanisms, hand and portable power tools, fire prevention.

1. State the steps that should be taken if a person with whom you were working became paralyzed from electrical shock.
2. List at least five safety precautions to be observed when working with any type of rotating machinery.
3. List at least five safety precautions to be observed when working with electrical circuits.

Technology 20 Human and Industrial Relations (2)

2 hours lecture
Prerequisite: Technical English 1 (or equivalent) and sophomore standing

Presents the historical, philosophical, and social bases for human relations. Case studies are used to emphasize the responsibilities of supervisors and subordinates in industrial (labor) relations.

1. Describe the principles of human relations and explain how and why these principles were derived.
2. Apply the principles of human relations to illustrate how these principles can be applied to resolve problems which may occur between workers, supervisors, and management.

(TECHNICAL ELECTIVE COURSES)

EET 110 Electronic Systems Analysis (4)

2 hours lecture, 6 hours laboratory
Prerequisite: EET 22

Video communication systems; principles of black-and-white and color television. Laboratory procedures and techniques for logical troubleshooting, equipment alignment and maintenance of video communication systems.

1. Given a sketch of the composite video, signal waveforms, identify the following points or signals: blanking level, reference white level, reference black level, front porch, back porch, horizontal blanking and sync pulses, vertical blanking and sync pulses and the equalizing pulses.
2. Given the appropriate equipment, demonstrate the ability to completely align a color television receiver.
3. Demonstrate the ability to perform proof-of-performance tests on a television transmitter.

EET 120 Computer Electronics (5)

3 hours lecture, 6 hours laboratory
Prerequisite: EET 22 and Computer 1 (Computer 1 may be taken concurrently)

The principles and design of logic circuits and systems, with emphasis on control and arithmetic processes in computers. Counter, register, and memory circuits; input and output devices; interface problems. Machine-language programming and troubleshooting on the digital computer.

1. Given a digital counter with one defective component and appropriate test equipment, locate the fault.
2. Given a keyboard, a multiplexed seven-segment display, appropriate integrated circuits and specifications, design and test a digital system which will interface the keyboard with the seven-segment time multiplexed display (read-out).

EET 130 Microwave Theory and Measurements (4)

3 hours lecture, 3 hours laboratory
Prerequisite: EET 21

Study of the theory and behavior of microwaves; microwave and VHF measurements, transmission lines and waveguide systems. Laboratory assignments include use of microwave equipment and techniques employed in microwave measurements.

1. Experimentally determine the resulting VSWR due to the insertion of an element in a microwave test bench.
2. Briefly describe the nature of operation of the following devices: traveling wave tube, reflex klystron, backward wave oscillator, directional coupler and parametric amplifier.
3. Given the characteristic impedance of the line and the load impedance, determine the VSWR and the impedance at any point on the line using a Smith chart.

EET 140 Advanced Electronic Communication Systems (3)

2 hours lecture, 3 hours laboratory (field trip)
Prerequisite: EET 21, EET 21L; EET 110 is recommended

An extended study of theory and practice involved in sophisticated electronic communication systems; calibration and troubleshooting techniques.

1. Without the use of reference material, draw the schematic diagram of a balanced modulator.
2. Describe the difference between a ratio detector and a Foster-Seely discriminator.
3. Describe how an analog signal may be converted to pulse amplitude modulation and to pulse code modulation.

EET 150 Electronic Fault Diagnosis (2)

6 hours laboratory
Prerequisite: EET 21, EET 21L (may be taken concurrently)

Study and practice to develop thought processes, techniques, and methods for determining faults in electronic equipment and systems.

1. Given a malfunctioning electronic device, identify the faulty component(s) with a minimum number of test procedures; e.g., demonstrate the time and effort approach to locate the faulty component(s).
2. Given the schematic of an electronic instrument used in the course of study, describe the probable symptoms for the failure of any given component.

EMT 23 Electromechanical Control Devices and Systems (4)

2 hours lecture, 6 hours laboratory
Prerequisite: EET 12 and EET 12L; EET 13 is recommended
(or equivalent)

A study of electromechanical control devices and instrumentation; open loop and closed loop control, including the concepts of stability and compensation in feedback systems.

1. Given a real or hypothetical linear electromechanical system, use appropriate test equipment and manufacturers' literature to determine the transfer characteristics of the components of the system.
2. Given the transfer characteristics of the components of a linear feedback system, construct a Bode Plot for the loop gain and use it to predict stability.
3. Given a system with one or more faulty components, make appropriate tests and measurements to isolate the faulty component(s).

EET 200 Special Projects (2-4)

1 hour consultation, 3 hours laboratory per unit
Prerequisite: Consent of instructor

Individual instruction is provided to enable the student to work on special projects and/or study selected topics not covered by scheduled course offerings.

1. Demonstrate the project and/or write a report including documentation of the project.

EET 300 Work Experience

Units and hours by arrangement
Prerequisite: Enrollment in EIT curriculum

Credit for supervised coordinated work experience in industry which contributes to the attainment of the student's vocational objective. It is recommended that work experience units not be substituted for required technical courses.

Computers 1 Programming Techniques (3)

3 hours lecture, 2 hours conference/laboratory
Prerequisite: Mathematics 1E

Introduction to BASIC and FORTRAN programming languages; use of computers for the solution of engineering problems.

EIT 12A Fabrication Techniques (2)

6 hours of laboratory/demonstrations
Prerequisite: EIT 11 (may be taken concurrently)

Basic hand skills required in construction and modification of electronic equipment. Familiarization with fabrication and assembly techniques typical of the electronics industry. Emphasis is on developing proficiency in manipulative skills.

1. Given an etched circuit board in operational condition, demonstrate proficiency in soldering by first removing at least six components and then replacing them without damaging the components or affecting the circuit operation.
2. Demonstrate ability to use metal-forming tools through the display of a chassis or similar object constructed during the course of study.
3. Demonstrate proficiency in electronics assembly techniques through the display of an electronics device built during the course of study.

EIT 12B Advanced Fabrication Techniques (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EIT 12A (or equivalent)

Continuation of instruction in fabrication and assembly techniques, with emphasis on more advanced skills. Instruction in electronic unit design and fabrication of printed circuits.

1. Describe the step-by-step procedures in the fabrication of an etched circuit board using photo resist and silk screen processes.
2. Describe the step-by-step procedure in the fabrication of a silk screen using pre-sensitized film.
3. Describe the step-by-step procedure to be followed in the anodizing of aluminum or enamel finishing of a front panel.

5. EMPLOYMENT OPPORTUNITIES

a. Students who successfully complete the first semester's technical course work will have the capabilities for employment in some types of electronic testing jobs.

b. Students who complete the first year's technical course work have job capabilities for employment as Installer (Radio/Television or Cable T.V.); Electronics Assembler (limited); Electronic Component Inspector--(Switching circuit components and simple vendor supplied components and devices).

Inasmuch as specialization occurs primarily by the selection of technical electives in the third and fourth semesters, the employment opportunities/job qualifications will depend upon the selection and sequence of the electives during the second year of the curriculum course work.

Technical electives can be selected to develop competency for employment opportunities as an Electronics Engineering Technician involving such job classifications as:

Product Service and Maintenance Technician
Instrument Technician
Computer Test/Service Technician
Research & Development Technician
Product Test Technician
Microwave Technician
Test and Calibration Technician
Communication Technician
Sales & Customer Service (various capacities)
Quality Control Technician
Systems Analysis-Test Technician
Medical Equipment Technician

C. ELECTRONICS INDUSTRIAL TECHNOLOGY

1. CURRICULUM PREREQUISITE

Minimum curriculum prerequisites should be established for this program. General high school mathematics or reasonable proficiency in arithmetic operations (qualifying score on placement test) is the recommended, and minimum, curriculum prerequisite.

2. CORE CURRICULUM (SUGGESTED SEQUENCE)

The core curriculum outlined below is based upon integration of adequate instruction in applied mathematic concepts, as required, in the technical courses. An alternative would be to include additional discrete courses in mathematics and reduce the unit value of the technical course work accordingly.

ELECTRONICS INDUSTRIAL TECHNOLOGY

(AS Degree Curriculum)

Suggested Sequence

First Semester:

EIT 11	Introduction to Electronics	5
EIT 12A	Fabrication Techniques	2
Math. IT-1	Industrial Mathematics	4
Tech. Engl. 1	Communication Skills & Report Writing	3
Technology 10	Occupational Safety & Health	2

Second Semester:

EIT 12B	Advanced Fabrication Techniques	3
EIT 13	Electronic Devices and Circuits	5
EIT 14	Introduction to Digital Circuits	3
Drafting 1E	Graphics for Electronics	3
*Electives		

Third Semester:

EIT 21	Applied Electronic Circuits	5
EIT 22	Troubleshooting Techniques	2
*Electives		

Fourth Semester:

EIT 23	Electronic Systems Analysis	4
*Electives		

*Electives should be selected to fulfill graduation requirements and provide a minimum of 18 units of technical elective courses. The technical elective courses should be selected by the student in consultation with the Curriculum Technical Advisor, or Counselor, to satisfy the student's occupational objective. Mathematics A, or Mathematics 1E, is recommended.

3. TECHNICAL ELECTIVES

These courses are intended to give the student greater depth in electronics and/or develop specialized knowledge and skills for specific employment opportunities.

EIT 110	Pulse Switching Circuits Applications	(3)
EIT 120	Radio-Telephone Communications	(3)
EIT 130	Electronics Maintenance and Repair	(4)
EIT 140	Television Theory and Servicing	(5)
EIT 200	Special Projects	(1-4)
EIT 300	Work Experience	(by arr.)
EMT 21	Electrical Machines and Controls	(3)
ET 100	Human and Industrial Relations	(2)
Math A	Fundamentals of Technical Mathematics	(4)
or Math 1E	Mathematics for Electronics	(4)

4. COURSE DESCRIPTIONS

(CORE CURRICULUM COURSES)

EIT 11 Introduction to Electronics (5)

3 hours lecture, 6 hours laboratory
Prerequisite: Mathematics IT-1 (or equivalent), may be taken concurrently

Fundamentals of electricity and magnetism, including DC and AC passive circuits. Introduction to basic electronic components and circuit applications. Laboratory exercises are designed to supplement lecture presentations, to familiarize the student with the use of instruments and measuring techniques, and to develop manipulative skills.

1. Analyze series DC circuits by finding values for all unknown voltages, currents, powers and resistances when given the schematic and sufficient information about the remaining components.
2. Given the values of any two Ohms' law variables, determine the third.
3. Given either a resistor, a capacitor or an inductor with rated values and tolerance, use suitable test equipment to determine if the device is within tolerance.

EIT 12A Fabrication Techniques (2)

6 hours laboratory/demonstrations
Prerequisite: EIT 11 (may be taken concurrently)

Basic hand skills required in construction and modification of electronic equipment. Familiarization with fabrication and assembly techniques typical of the electronics industry. Emphasis is on developing proficiency in manipulative skills.

1. Given an etched circuit board in operational condition, demonstrate proficiency in soldering by first removing at least six components and then replacing them without damaging the components or affecting the circuit operation.
2. Demonstrate ability to use metal-forming tools through the display of a chassis or similar object constructed during the course of study.
3. Demonstrate proficiency in electronics assembly techniques through the display of an electronics device built during the course of study.

EIT 12B Advanced Fabrication Techniques (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EIT 12A (or equivalent)

Continuation of instruction in fabrication and assembly techniques, with emphasis on more advanced skills. Instruction in electronic unit design and fabrication of printed circuits.

1. Describe the step-by-step procedure in the fabrication of an etched circuit board using photo resist and silk screen processes.
2. Describe the step-by-step procedure in the fabrication of a silk screen using pre-sensitized film.
3. Describe the step-by-step procedure to be followed either in the anodizing of aluminum or enamel finishing of a front panel.

EIT 13 Electronic Devices and Circuits (5)

3 hours lecture, 6 hours laboratory
Prerequisite: EIT 11 and EIT 12A (or equivalent)

Continuation of the study of electronic components and circuits including vacuum tube and transistor amplifiers, audio circuits, oscillators, power supplies; construction and testing of simple active circuits. Use of test instruments and measuring techniques. Emphasis is on applications.

1. Given suitable test equipment and a transistor, determine the condition of the transistor.
2. Given the schematic of a simple transistor amplifier circuit, breadboard the circuit and experimentally determine the voltage gain.
3. Given an oscilloscope, a parallel LC circuit and a signal generator, determine the resonant frequency and bandwidth of the circuit.

EIT 14 Introduction to Digital Circuits (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EIT 13

Instruction in basic digital techniques, circuits and systems. Required mathematics, including binary number system, is presented in the lectures.

1. Given the schematic of an astable multivibrator circuit using bipolar transistors, breadboard the circuit and determine the frequency.
2. Describe the basic differences between astable, bistable, and monostable multivibrators.
3. Given a set of (+or -) binary numbers, perform the required arithmetic operations to solve assigned problems.

EIT 21 Applied Electronic Circuits (5)

3 hours lecture, 6 hour laboratory
Prerequisite: EIT 13; EIT 14 is recommended

A study of practical applications of radio frequency circuits, modulation and transmitters, receivers, pulse circuits, and industrial electronics. Measurement and testing techniques are stressed in laboratory work.

1. Given an operating RF oscillator and suitable test equipment, determine the frequency within the accuracy of the test equipment.
2. Given a circuit containing digital integrated circuits and appropriate test equipment, determine the circuit conditions (high, low, pulse) at any point.
3. Without the use of reference material, draw the schematic of a full wave bridge rectifier followed by a pi section filter.

EIT 22 Troubleshooting Techniques (2)

1 hour lecture, 3 hours laboratory
Prerequisite: EIT 12B; EIT 15 (may be taken concurrently)

Instruction in the most effective means of determining the faults in electrical and electronic systems and the proper methods of repair. Emphasis on procedural techniques to analyse systems.

1. Demonstrate the ability to replace any component on an etched circuit board without damage to the board or to any other component.
2. Given a transistor audio amplifier with a defective transistor, use signal tracing techniques to locate the faulty transistor.
3. Orally describe the general procedure to follow in troubleshooting a given electronic system.

EIT 23 Electronic Systems Analysis (4)

3 hours lecture, 3 hours laboratory
Prerequisite: EIT 14 and EIT 21

Instruction in the similarities and differences of basic electronic systems (in communications, industrial processes and controls, and digital) correlating the techniques used to perform tests, calibration, and maintenance procedures on the systems.

1. Given an electronic system, describe the test procedures and corrective action required to properly calibrate the components.
2. Describe preventative maintenance procedures which would facilitate proper performance of a given electronic system.

Drafting 1E Graphics for Electronics (2)

6 hours lecture-laboratory
Prerequisite: One year high school drawing (or equivalent)

Practice in preparation and interpretation of block diagrams, schematic diagrams, pictorials, and introduction to the use of drawing systems and standards such as American National Standards Institute, National Electrical Code and Military Standards in the preparation and interpretation of interconnection and wiring diagrams, commercial and industrial wiring, and fundamentals of printed circuit board design.

1. Lay out the design of a printed circuit board from a simple schematic.
2. Given a chassis containing a simple circuit, draw the circuit schematic in accordance with the standards established by the American National Standards Institute.

Math IT-1 Industrial Mathematics (4)

3 hours lecture, 2 hours problem-solving sessions
Prerequisite: Qualifying score on mathematics placement test

A review of arithmetic fundamentals; basic mathematics for industrial use, including an introduction to the fundamental concepts of algebra, geometry, and trigonometry. Use of calculators; metric system of units and measure. Concepts and techniques are introduced in the lectures; exercises and practical applications relative to the student's curriculum are provided in the problem-solving sessions. (This course is primarily designed for those students entering vocational or industrial technology program .)

1. Solve assigned problems to demonstrate an acceptable level of proficiency and knowledge of fractions, decimals, percentages, ratios and proportions.
2. Given a regular geometric shape and appropriate dimensions, solve the algebraic equation for the area or volume.
3. Given a binomial, solve the expression for any of the literal numbers.
4. Given two sides, or an angle and one side, of a right triangle, solve for the angle(s) and/or the sides of the triangle.

Technical English 1 Communications Skills and Report Writing (3)

2 hours lecture, 2 hours laboratory-conference
Prerequisite: Qualifying score on placement test

Instruction and practice in communication of both oral and written information. Emphasis on techniques for writing various types of technical communication and reports. Assistance with the writing of laboratory reports is provided during the laboratory-conference sessions.

1. List and describe the three frames of reference from which a mechanism, or electronic device, may be described.
2. Write a suitable topic sentence (generalization) which can be developed by five or more supportive statements, joined coherently.
3. Plan and write a report based on experimental data collected in a laboratory course; also prepare an outline and deliver an oral presentation on the report subject.

Technology 10 Occupational Safety and Health (2)

2 hours lecture
Prerequisite: None

Employer and employee responsibility, Federal and State legislation, accident reports, industrial hygiene, personal protective equipment, materials handling and storage, guarding machines and mechanisms, hand and portable power tools, fire prevention.

1. State the steps that should be taken if a person with whom you were working became paralyzed from electrical shock.
2. List at least five safety precautions to be observed when working with any type of rotating machinery.
3. List at least five safety precautions to be observed when working with electrical circuits.

(TECHNICAL ELECTIVES)

EIT 110 Pulse and Switching Circuits Applications (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EIT 14

Instruction in applications of circuitry as applied to non-sinusoidal signals; pulse, switching and timing circuits.

1. Orally describe the basic principles and action of an SCR.
2. Describe the difference between AND, OR, NAND, and NOR gates.
3. Using an oscilloscope, measure the rise time, fall time, and width of a pulse.

EIT 120 Radio-Telephone Communications (3)

3 hours lecture
Prerequisite: EIT 13

Designed to prepare students for the First or Second Class FCC Radio-Telephone License examination.

1. Draw the block diagram of a plate modulated transmitter, consisting of an oscillator, buffer, doubler, final, audio pre-amplifier, amplifier and modulator.
2. Given values for two of the four frequencies of a superhetrodyne receiver (desired input, image, local oscillator and IF), calculate the remainder.
3. Given an AM display either in trapezoidal or time base form, determine the percent modulation.

EIT 130 Electronics Maintenance and Repair (4)

2 hours lecture, 6 hours laboratory
Prerequisite: EIT 13

Provides basic instruction and laboratory experience in skills required for employment in the radio, TV, and appliance repair field.

1. Given an AM-FM receiver with a defective stage, locate the faulty stage using signal injection techniques.
2. Align a FM receiver using sweep frequency techniques.
3. Given a stereo amplifier with a single defective component, locate and correct the fault using appropriate test equipment.

EIT 140 Television Theory and Servicing (5)

3 hours lecture, 6 hours laboratory
Prerequisite: EIT 13 (EIT 21 and 22 recommended)

The theory of operation and servicing techniques of black-and-white and color television.

1. Given a monochrome television receiver with a defective component that noticeably affects reception, the schematic diagram and appropriate test equipment, locate the faulty component.
2. Demonstrate the ability to obtain purity and converge a color television receiver.
3. Without the use of references, draw the block diagram of a color television receiver.

EIT 200 Special Projects (1-4)

Hours by arrangement
Prerequisite: Consent of instructor

Special electronic projects

1. Demonstrate the project and/or write a report including documentation of the project.

EIT 300 Work Experience

Units and hours by arrangement
Prerequisite: Enrollment in EIT curriculum

Credit for supervised coordinated work experience in industry which contributes to the attainment of the student's vocational objective.

EMT 21 Electrical Machines and Controls (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EMT 11 and EMT 12 (or equivalent)

A study of alternating- and direct-current power equipment, including motors, generators, converters, transformers, and controls.

1. Given an AC or DC motor (or generator) and the required auxilliary components and instrumentation, design the circuit, connect the components, and perform all tests required to verify proper function of the system. Explain the operating characteristics of the motor.
2. Given a three-phase motor installation, draw a schematic diagram of the control and circuit wiring and describe (explain) the function of all components.
3. Given an AC or DC power source and specified power requirements to operate a component, identify and describe the specifications of the transformer, converter, and/or other devices required to achieve the required conversion.

Technology 20 Human and Industrial Relations (2)

2 hours lecture
Prerequisite: Technical English 1 (or equivalent) and
sophomore standing

Presents the historical, philosophical, and social bases for human relations. Case studies are used to emphasize the responsibilities of supervisors and subordinates in industrial (labor) relations.

1. Describe the principles of human relations and explain how and why these principles were derived.
2. Apply the principles of human relations to illustrate how these principles can be applied to resolve problems which may occur between workers, supervisors, and management.

Math A Fundamentals of Technical Mathematics (4)

3 hours lecture, 2 hours problem-solving session
Prerequisite: One year high school algebra (or equivalent--
qualifying score on placement test)

A brief review of basic arithmetic operations and elementary algebra. Instruction in the fundamentals of algebra, geometry, right angle trigonometry with emphasis on problem-solving techniques as applied to typical problems encountered in technology curriculums. Use of computational devices (calculators).

Concepts and techniques are introduced in the lectures; exercises in practical applications and individual tutoring are provided in the problem-solving sessions.

1. Given a quadratic equation, solve for the unknown variable.
2. Given two independent linear equations with two unknowns, solve for the unknown variables.
3. Given a right triangle with two sides (or an angle and one side) known, solve for the unknown angles and sides by using trigonometry.
4. Given the resultant vector, resolve that vector into its X and Y components; also given the X and Y components, determine the resultant vector.

5. EMPLOYMENT OPPORTUNITIES

a. Students who successfully complete the first semester of the EIT curriculum may qualify for employment as an Electronic Assembler or limited types of electronic testing jobs.

b. Students who successfully complete the first year of the EIT curriculum may qualify for employment as:

Radio/T.V. Installer
Cable T.V. Installer
Electronic Parts Inspector (limited)
Switching Circuit Component Tester
Electronics Assembler

c. Students who successfully complete the AS degree curriculum outlined above should qualify for employment, including the following:

Product Service Technician
Maintenance Technician (electronics)
Radio Television Repairman
Cable Television Service Technician
Electronic Product Test Technician
Electronic Equipment Repairman
Electronic Quality Control Technician
Automotive Test Equipment Repair and Calibration Technician
Electronic Equipment Calibration Technician
Environmental Test Technician

D. CERTIFICATE PROGRAMS

A considerable variety of programs can be developed from the courses listed in the Electronics Engineering Technology and/or the Electronics Industrial Technology curriculums. For example, a program to prepare a student for FCC examinations for First or Second Class Radio-Telephone license could be derived from either curriculum.

EET 11	5	EIT 11	5
EET 11L	2	EIT 12A	2
EET 12	5	EIT 13	5
EIT 120	3	EIT 21	5
		EIT 120	3
	15 units(1)		20 units(1)

Other feasible certificate programs can be identified by correlating the required employment capabilities commensurate with selected course work in each curriculum.

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(1) Additional courses in mathematics might be added depending upon the background of the particular student.

MECHANICAL TECHNOLOGY

This section will include course and curriculum recommendations for Mechanical Engineering Technology and Mechanical Industrial Technology.

A. GENERAL REMARKS--SURVEY DATA

B. MECHANICAL ENGINEERING TECHNOLOGY
    1) Curriculum Prerequisite
    2) Core Curriculum (Suggested Sequence)
    3) Technical Electives
    4) Course Descriptions
    5) Employment Opportunities

C. MECHANICAL INDUSTRIAL TECHNOLOGY
    1) Curriculum Prerequisite
    2) Core Curriculum (Suggested Sequence)
    3) Technical Electives
    4) Course Descriptions
    5) Employment Opportunities

A. GENERAL REMARKS -- SURVEY DATA

In the conceptual stage of this project it was assumed that the general format and treatment of the four discipline areas would follow essentially the same pattern. The results of the data developed from Questionnaire A(1) clearly indicated that the family of curriculums in the mechanical area would require special consideration and modified treatment. The diverse nature of the family of mechanical curriculums presents a formidable problem in developing a curriculum guide.

A second survey was conducted to develop more comprehensive data.(2) A sample of 70 community colleges was included in the survey. A tabulation of the 62 responses is shown in Table 1 on the following page. It will be noted that 30 titles were included in the responses (including one eligible write-in).

Moreover, instruction in "vending machine repair" is offered in some existing programs. For example, some community colleges offer vending machine repair in T & I curriculums; some include the instruction as an option in Electronics Industrial Technology curriculums. This option is also offered in the "Mechanical-Electrical Technology" curriculum at one community college.

A summary of these data indicated that 180 industrial technology curriculums are offered under 28 separate titles, and 45 engineering technology curriculums are offered under 16 separate titles. This information clearly indicated that the programs in mechanical technology would require some special treatment. Certainly, a common core could not be established which would satisfy the large number of existing industrial technology curriculums. On the other hand, the voluminous task of outlining a separate guide for each program title would provide little or no value nor would it conform with the expressed purpose of this project. It is therefore the intent to identify the threads of commonality and attempt to weave them into useable core curriculums with appropriate options.

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(1) See Appendix I, page 117: 26 Community Colleges reported 48 curriculums under 27 separate titles.

(2) See Questionnaire B; Appendix I, page 118.

TABLE I

TABULATION OF QUESTIONNAIRE(B) RESPONSES[1]

Curriculum Title	(T & I)	(IT)	(ET)
1. Air Condition & Refrigeration	16	11	2
2. Aero. Production & Plan.	1	1	
3. Aircraft Maintenance	7	11	
4. Aircraft Production	1	2	
5. Airframe & Power Plant	6	12	1
6. Automotive Tech.	37	17	2
7. Diesel Mech.	13	6	
8. Fluid Power	4	2	
9. Heating & Ventilation	5	1	
10. Industrial Tech.	2	14	3
11. Machine Design	2	3	6
12. Machine Shop Tech.	30	19	
13. Manufacturing Tech.	4	12	1
14. Marine Mechanics	2		
15. Material Evaluation	3	3	2
16. Mechanical-Electrical Tech.[2]	2	9	6
17. Mechanical Servicing	1	1	
18. Mechanical Tech.		7	8
19. Metal Tech.	7	7	
20. Metallurgical Tech.	4	3	3
21. Metrology	3	1	
23. Numerical Control	7	6	2
24. Plastic Prod.	3	2	
25. Production Tech.	2	3	1
26. Quality Control (Assurance)	5	7	4
27. Tool & Die	5	5	
28. Vacuum Tech.	1		1
30. Welding	28	15	2
Other: Instrumentation			1
TOTAL	211	180	45

No responses for the following: 22. Nuclear Tech.
29. Vending Machine Repair

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[1] See Appendix I

[2] Curriculums listed as Electro-Mechanical were included in this tally.

To explore this concept further, it is apparent that curriculums in aircraft power plant, airframe, etc., are structured to comply with regulations of the Federal Aviation Administration and therefore are not included in the core curriculum design in this publication. Because of the highly specialized nature of programs in automotive and welding disciplines, the following qualifications will apply:

1. The core curriculum in mechanical engineering technology may well provide a base for options in automotive or welding for students who wish to enter these fields as engineering technicians or to matriculate into a (BET) or (BIT) program.
2. If the core curriculum for mechanical engineering technology is adopted, the community college may choose to supplement the technical elective courses listed to include additional course work in automotive or welding based upon local employment opportunities.
3. The Mechanical Industrial Technology core, with appropriate technical elective courses, may be satisfactory for certain employment classifications as automotive technicians or welding technicians; however, it is unlikely that graduates of this curriculum would receive comparable depth of training in manipulative skills as would graduates of more specialized automotive or welding curriculums. On the other hand, it is reasonable to expect that the Mechanical Industrial Technology curriculum would provide a broader educational experience and excellent opportunities for career advancement.

The adoption of the core curriculum in mechanical engineering technology and/or mechanical industrial technology should provide an economic advantage for the community college. Moreover, the core curriculum(s) would provide the student greater flexibility in the determination, or confirmation, of his educational objective and increased opportunities for mobility among technical programs. There is substantial evidence that a large number of students are uncertain about their educational/occupational objective when they enter the community college thus making a broad-based core curriculum especially significant.

To establish general guidelines for the mechanical technology category we will use the definition developed at the "Consultants Workshop on Mechanical Technology" as a frame of reference. (1)

> Mechanical Technology pertains to that group of curriculums which provide technicians for fields related to mechanical engineering...the curriculums included may be intended to produce either industrial technicians or engineering technicians. Trade level and craft level are specifically excluded...

The primary educational objective for all curriculums outlined in the following material is to provide adequate knowledge and skills for employment, at various entry levels, and for career advancement. Specific employment qualifications are included in the sections dealing with the particular curriculum. The curriculum in Mechanical Engineering Technology will also provide matriculation opportunities to those students who wish to continue their education in either the (BET) or (BIT) programs.

B. MECHANICAL ENGINEERING TECHNOLOGY

1. CURRICULUM PREREQUISITE

The recommended curriculum prerequisite is satisfactory completion of high school trigonometry (or equivalent) and a course in mechanical drawing.

The minimum prerequisite is intermediate algebra (equivalent competency in algebra) and high school mechanical drawing.

In addition, a desirable supplement for either prerequisite cited above would include a course in high school general science or physics.

2. CORE CURRICULUM (SUGGESTED SEQUENCE)

The following outline and suggested sequence of courses is based upon the minimum curriculum prerequisite. If the recommended curriculum prerequisite is adopted, the first semester

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(1) Proceedings of a Consultants Workshop on Technologies Related to Mechanical Engineering, American Association of Junior Colleges, San Antonio, 1968.

MECHANICAL ENGINEERING TECHNOLOGY

(AS Degree Curriculum)

Suggested Sequence

First Semester:

(1)MET 11	Metal Cutting Processes	2
Drafting 1	Fundamentals of Engineering Drafting	3
MET 12	Mechanisms I	2
Math. 1	Applied Technical Mathematics	4
(2)Physics 1	Technical Physics	3
Technology 10	Occupational Safety & Health	2

Second Semester:

EMT 11	Introduction to Electricity, D.C.	2
MET 13	Materials	2
MET 13L	Materials Laboratory	1
MIT 13	Welding Fundamentals	3
(3)Math. 2	Advanced Technical Mathematics	3
Tech. Engl. 1	Communication Skills & Report Writing	3
*Electives		

Third Semester:

EMT 12	Introduction to Electricity, A.C.	2
MET 21	Manufacturing Processes	3
MET 22	Mechanisms II	2
MET 23	Fluid Mechanics	3
*Electives		

Fourth Semester:

Computers 1	Programming Techniques	3
EMT 21	Electrical Machines & Controls	3
Technology 20	Human and Industrial Relations	2
*Electives		

*Electives should be selected to fulfill graduation requirements and provide technical elective courses. A minimum of 10 semester units of technical elective courses should be selected by the student in consultation with the Curriculum Technical Advisor, or Counselor, to satisfy the student's occupational objective.

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(1) MIT 11 may be substituted for MET 11.

(2) Physics 11 may be substituted for Physics 1, see page 90 for Physics 11 course description.

(3) Although Math. 2 is listed in the core curriculum, some colleges may choose to offer this course as a recommended elective.

course in mathematics may be reduced by one unit, and instruction in mathematics in the technical courses may be minimized. The additional time thus gained may be used to provide greater in-depth instruction in the technical courses. Descriptions of typical remedial courses are included in Appendix IV. These courses are designed to allow the student to remove high school deficiencies and thereby satisfy the recommended curriculum prerequisite.

Students who satisfactorily complete the curriculum outlined on page 52 will be well qualified for employment as mechanical engineering technicians. Moreover, successful completion of the core curriculum and suitable electives will satisfy the articulation requirements for the (BET) degree program (see Appendix II).

3. TECHNICAL ELECTIVES

The survey data discussed in Section A suggests a large number of possible options. Three will be considered: (a) Mechanical Design, (b) Manufacturing and Production Control, and (c) Research-Prototype Development. In the list of courses below the letters in brackets [a,b,c] indicate the options for which the course would be a suitable technical elective. Chemistry 101 is recommended for students who intend to transfer to complete a four-year (BET) program.

Chemistry 101	Technical Chemistry	(4)	[c]
Drafting 2	Technical Drafting	(2)	[a]
Drafting 110	Machine Design	(4)	[a]
MET 110	Metrology	(2)	[a,b,c]
MET 120	Heat Power	(3)	[a,c]
MET 130	Production Quality Control	(2)	[b]
MET 140	Introduction to Numerical Control	(3)	[a,b,c]
MET 150	Vacuum Technology	(3)	[c]
MET 200	Special Projects	(2-4)	[a,b,c]
MET 300	Work Experience		

MIT 12	Advanced Machine Shop	(3)	[a,b]
MIT 110	Tool and Die Design	(3)	[b]
MIT 14	Advanced Welding Practices	(3)	[b]
MIT 170	Fundamentals of Refrigeration Systems	(3)	[a,c]

4. COURSE DESCRIPTIONS

(CORE CURRICULUM COURSES)

MET 11 Metal Cutting Processes (2)

1 hour lecture, 3 hours laboratory
Prerequisite: None

Instruction in principles and applications of metal cutting. Laboratory experience in the operation of basic lathe and milling machine; drill press, off-hand grinder, and hand tools. Emphasis on shop safety practices.

1. Indicate a sufficient appreciation of shop safety practices by answering all questions correctly on a shop safety test and demonstrate proper safety practices in the laboratory.
2. Given the specifications for a simple part, perform the machining operations using a lathe, drill press, and milling machine. Satisfactory performance will include attainment of some dimensions to a tolerance of ± 0.001 inches.

MET 12 Mechanisms I (2)

4 hours lecture/laboratory
Prerequisite: Mathematics 1 and Physics I or II (may be taken concurrently)

An introductory course in mechanisms: gears, levers, cams, and combination mechanical drives. Instruction in basic concepts of statics.

1. Given various mechanisms which include gears, cams, and levers, identify and list each component and describe the function of the component relative to the operation of the mechanism.
2. Given a mechanism including a gear train and levers, experimentally determine and analytically solve the relationship between input and output in terms of displacement, velocity, and torque (or moment).
3. Given a mechanism in static equilibrium, sketch free-body diagrams of and determine the forces acting on the assigned parts.

MET 13 Materials (2)

2 hours lecture
Prerequisite: Physics 1 or 11; MET 11 (or equivalent)

Properties of materials and the influence of these properties on engineering use of the materials.

1. Without the use of reference material, list and describe at least four properties of materials. Materials may be ferrous or non-ferrous metals, or plastics.
2. Given a set of design conditions, identify and compare the properties of various metals and non-metals which would satisfy the property requirements of the design conditions. Reference sources may be used.

(1)MET 13L Materials Laboratory (1)

3 hours laboratory
Prerequisite: Concurrent enrollment in MET 13

Laboratory exercises in metallurgy; testing, heat treatment, and mechanical working.

1. Perform the necessary tests to determine the hardness and tensile strength of a given set of metallic and non-metallic specimens.
2. For a given set of specifications, conduct the required tests and write a report, including a description of the procedures used, an analysis of the results, and conclusions which are verified by the test data.

MET 21 Manufacturing Processes (3)

2 hour lecture, 3 hours laboratory
Prerequisite: MET 11, MET 13 is recommended

Fundamentals of forming metals and non-metals; instruction in mass production planning and manufacturing techniques and processes; metal cutting processes, casting, extruding, powder metallurgy, forging. Introduction to numerical control machine tool operation.

1. List at least two advantages and one limitation for each of the following manufacturing processes: metal cutting, casting (sand and die), forging, extruding (plastic and metal), and powder metallurgy.
2. Given the design specifications of an assembly of parts,
    a) Write a report describing various manufacturing processes which could be used to economically manufacture

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(1) MET 13 and MET 13L may be offered as a 3 semester-unit lecture course if laboratory facilities are not available.

the parts, and b) make and assemble the parts within the dimensional tolerances specified.

MET 22 Mechanisms II (2)

4 hours lecture/laboratory
Prerequisite: MET 12 and Mathematics 2 (Math. 2 may be taken concurrently)

A study of kinematics and kinetics applied to mechanisms: cams, linkages, couplings, brakes, clutches, and electro-mechanical devices.

1. Given the necessary equipment and specifications, construct a multiple cam timing mechanism and perform the necessary tests to check-out the operation of the mechanism. Test results must agree with the specifications within ± 2%.
2. Given the relationship of time and one of three variables (displacement, velocity, or acceleration), construct the motion diagrams to determine the values of the unknown variables. Either rectilinear or curvilinear (rotation) motion may be involved.
3. Given a rotating mechanism for which the mass of the rotating member and the angular velocity can be varied, determine the kinetic energy of the mechanism for varying values of mass and angular velocity. Report the results in both Egs. and SI units.

MET 23 Fluid Mechanics (3)

2 hours lecture, 3 hours laboratory
(or 3 hours lecture)
Prerequisite: Mathematics 1 and Physics 1 or 11

Analysis of problems associated with fluid flow, hydraulics; measurement techniques; pump and fan performance characteristics.

1. Given a hydraulic system (including a pump, an orifice, a venturi, and connecting piping) and appropriate measuring devices and reference material, make the necessary measurements to calculate values of flow velocity and capacity, hydrostatic forces, and pipe line losses at or between given points in the system.
2. Demonstrate an understanding of fluid flow by defining terms and solving problems involving axial fan operation, duct flow, hydraulic gradient, and work and energy interchange.

Drafting 1 Fundamentals of Engineering Drafting (3)

6 hours of lecture/laboratory
Prerequisite: High school mechanical drawing recommended

Fundamentals of orthographic projection and descriptive geometry as applied to engineering drawings.

1. Given a model, or a pictorial drawing, of a part, demonstrate an understanding of geometric construction and orthographic projection by accurately drawing the views required to describe the part.
2. Demonstrate an understanding of the fundamentals of descriptive geometry by solving problems requiring the determination of true length of a line, true shape of a plane, and the distance between a point and a plane.

EMT 11 Introduction to Electricity, D.C. (2)

1 hour lecture, 3 hours laboratory
Prerequisite: Mathematics 1 and Physics 1 or 11 (may be taken concurrently)

Instruction in the fundamentals of electricity using passive and active devices in D.C. circuits; techniques of measurements.

1. Given any two of the values for voltage, current, and/or resistance, use Ohm's law to solve for the unknown value.
2. Given a series or parallel circuit, values of input current and voltage, and known resistance values, solve for the output current and voltage.
3. Given a DC circuit, a voltmeter, ammeter, and ohmmeter, perform the necessary measurements to determine the values of current, emf, and resistance for specified points in the circuit.

EMT 12 Introduction to Electricity, A.C. (2)

1 hour lecture, 3 hours laboratory
Prerequisite: EMT 11

Instruction in the fundamentals of electricity and magnetism using passive and active devices in both D.C. and A.C. circuits; techniques of measurements.

1. Demonstrate an understanding of Faraday's law, Lenz's law, and B-H curves by solving assigned problems involving magnetism and induced emf.
2. Given a schematic of a series or parallel circuit which includes resistance, inductance, and capacitance, two of which have known values, calculate the unknown value. Construct the circuit in the laboratory--verify the calculated value of the unknown and the resonance frequency of the circuit using appropriate instrumentation.

3. Given an amplification circuit which includes a transistor, select appropriate instrumentation, obtain data, and plot a graph to illustrate the amplification characteristics. Write a description of amplification characteristics using mechanical and fluid systems to illustrate the definition (reference "unified physics" concepts).

EMT 21 Electrical Machines and Controls (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EMT 11 and EMT 12 (or equivalent)

A study of alternating- and direct-current power equipment, including motors, generators, converters, transformers, and controls.

1. Given a schematic diagram of a D.C. motor control and the necessary instruments and equipment, properly connect the motor and control, perform the tests required to identify the operating characteristics, and write a summary of the operating characteristics.
2. Given specifications, required data, and appropriate reference material for an A.C. motor (or generator), make a schematic diagram and the necessary computations to demonstrate an understanding of the operation of the equipment and its operating characteristics.

MIT 13 Welding Fundamentals (3)

6 hours lecture-laboratory
Prerequisite: None

An introductory course in the theory, practice and applications of various welding processes. Fundamentals of oxy-acetylene welding and electric arc welding, including brazing, flame cutting, M.I.G. and T.I.G. processes. Emphasis on shop safety practices.

1. Correctly answer all questions on a safety test without using reference material and demonstrate proper safety procedures in the welding laboratory.
2. Given the required material and equipment, butt weld two steel plates using an electric arc and perform a tensile test on the welded parts. The weld strength should not be less than 70% of the strength of the material of the parts.
3. Without references, list at least two applications where it would be advantageous to use oxy-acetylene welding, electric arc welding, and MIG or TIG welding.

Computers 1 Programming Techniques (3)

2 hours lecture, 2 hours conference/laboratory
Prerequisite: Mathematics 1

Introduction to BASIC and FORTRAN programming languages; use of computers for the solution of engineering problems.

Math. 1 Applied Technical Mathematics (4)

3 hours lecture, 2 hours problem-solving session
Prerequisite: Intermediate algebra (Mathematics A or equivalent is recommended)

A brief review of geometry; fundamentals of trigonometry. Instruction in graphical and analytical methods and techniques used to solve practical problems involving algebra, geometry, and trigonometry; logarithms and their applications; use of calculators and other computational devices; S I units and English/metric conversions are included.

Theory, problem-solving techniques, and general applications are presented in lectures; treatment of specific problems encountered in concurrent technical course work and other typical engineering problems are included in problem-solving sessions.

1. Given an equation of three or more variables of which one is unknown and the dimensions of the known variables are expressed in non-Sl units (the equation is used in the discipline of the student's curriculum objective), perform the necessary dimensional analysis and solve the equation expressing the solution in Sl units. A calculator (or slide rule) may be used.
2. Given a coplaner concurrent vector system of three or more vector quantities, calculate and properly express the vector value of the resultant. A calculator (or slide rule) may be used.
3. Given a mensuration problem involving three unknown variables, one of which is an angle expressed in radians, and the necessary data to establish three independent equations, solve the problem to determine the values for all variables. A calculator (or slide rule) may be used.

Math. 2 Advanced Technical Mathematics (3)

2 hours lecture, 2 hours problem-solving session
Prerequisite: Mathematics 1 or 1E

Instruction in applied mathematics including an introduction to the basic concepts of analytical geometry, differential and integral calculus, and statistics; emphasis on applications to problems encountered by the engineering technician. Theory, techniques, and general applications are presented in the lectures; specific applications and problem-solving procedures and techniques are included in the problem-solving sessions. (Note--the objective of this course is to familiarize the student with applications of advanced mathematical techniques and develop greater proficiency in the use of algebra and trigonometry and problem-solving techniques and procedures.)

1. Given a set of problems related to the discipline of the student's curriculum objective, demonstrate proficiency in the use of algebra, geometry, and trigonometry by obtaining correct solutions to the problems. A calculator and appropriate reference material may be used.
2. Given a set of data consisting of 30 or more sample values, plot the distribution and calculate the mean and standard deviation for the sample.
3. Given a set of equations including those of a straight line, a parabola, a circle, and an ellipse, construct a graph of each equation to identify the geometric form represented by the equation.
4. Given an equation of the relationship of two variables (such as velocity and time), construct a graph of the equation and solve for the derivative value and integral valve for specified values of the independent variable. Both graphical and analytical methods should be used.

Physics 1 Technical Physics (3)

2 hours lecture, 3 hours laboratory
Prerequisite: Mathematics A and Physics A (or equivalent); Mathematics 1 or 1E is recommended, may be taken concurrently

Lectures, demonstrations, and laboratory exercises in the fundamental concepts of mechanics, electricity, fluids, and heat. (Refer to Physics 11, Page 90 for an alternative course -- "Unified Physics").

1. Experimentally determine the natural resonant frequency of a mechanical system consisting of a mass and a spring.
2. Given a circuit containing resistors and capacitors connected to a D.C. source, determine the energy stored in each capacitor.

Technical English 1 Communication Skills and Report Writing (3)

2 hours lecture, 2 hours laboratory-conference
Prerequisite: Qualifying score on English placement test

Instruction and practice in communication of both oral and written information. Emphasis on techniques for writing various types of technical communication and reports. Assistance with the writing of laboratory reports is provided during the laboratory-conference sessions.

1. List and describe the three frames of reference from which a mechanism, or electronic device, may be described.
2. Write a suitable topic sentence (generalization) which can be developed by five or more supportive statements, joined coherently.
3. Plan and write a report based on experimental data collected in a laboratory course; also prepare an outline and deliver an oral presentation on the report subject.

Technology 10 Occupational Safety and Health (2)

2 hours lecture
Prerequisite: None

Employer and employee responsibility, Federal and State legislation, accident reports, industrial hygiene, personal protective equipment, materials handling and storage, guarding machines and mechanisms, hand and portable power tools, fire prevention.

1. State the steps that should be taken if a person with whom you were working became paralyzed from electrical shock.
2. List at least five safety precautions to be observed when working with any type of rotating machinery.
3. List at least five safety precautions to be observed when working with electrical circuits.

Technology 20 Human and Industrial Relations (2)

2 hours lecture
Prerequisite: Technical English 1 (or equivalent) and sophomore standing

Presents the historical, philosophical, and social bases for human relations. Case studies are used to emphasize the responsibilities of supervisors and subordinates in industrial (labor) relations.

1. Describe the principles of human relations and explain how and why these principles were derived.
2. Apply the principles of human relations to illustrate how these principles can be applied to resolve problems which may occur between workers, supervisors, and management.

(TECHNICAL ELECTIVE COURSES)

(1)Chemistry 101 Technical Chemistry (4)

3 hours lecture, 3 hours laboratory
Prerequisite: One year high school algebra or qualifying score on mathematics placement test, (e.g., eligibility for Mathematics A)

An elementary presentation of the fundamentals of chemistry designed to fulfill the needs of students majoring in technology programs.

Drafting 2 Technical Drafting (3)

6 hours lecture-laboratory
Prerequisite: Drafting 1, MET 12; concurrent enrollment or completion of MET 21 recommended

Basic instruction and practice in the design procedures and delineation of simple machine parts; working drawings, precision dimensioning, including geometric tolerancing. Modern commercial drafting-room equipment and practices are employed.

1. Given all required design specifications for a part, make a detail drawing of the part including all required size and shape description.
2. List the steps involved in the development of a design from the idea stage to the manufactured product.
3. Given the required design specifications, demonstrate drafting skills and knowledge by delineating and dimensioning working drawings for weldments, castings, and parts requiring various machining operations.

Drafting 110 Machine Design (4)

2 hours lecture, 6 hours laboratory
Prerequisite: Drafting 2, and MET 13; MET 22 recommended (may be taken concurrently)

Advanced concepts of engineering design. Instruction in stress analysis (strength of materials) to enable students to design mechanisms and major assemblies. Methods of manufacture, tool design, and design verification (inspection), are considered.

1. Given the fundamental design specifications of a mechanism consisting of several (5 or more) parts, an explanation of the function of the mechanism, and appropriate reference materials, perform all required activities (including strength of materials analysis) to delineate all parts of the mechanism. The end product will include all required

computations, an assembly drawing, and detail (working) drawings for each part; moreover, the detail drawings will include all size and shape information required to ensure proper function of the mechanism and the information required to manufacture the parts.

MET 110 Metrology (2)

2 hours lecture-demonstration
Prerequisite: Mathematics 2; MET 21 (may be taken concurrently)

A study of precision measuring and gaging devices and techniques; concepts of errors and probability of errors.

1. Make a list of measuring instruments including a description of procedures required to determine surface finish and dimensional accuracy including size and geometry.
2. Given the functional specifications of a part (including a detail drawing), list the gages and measuring devices and write the inspection procedures which could be used to verify the functional acceptability of the part.

MET 120 Heat Power (3)

3 hours lecture, or 2 hours lecture and 3 hours laboratory
Prerequisite: Mathematics 2 and Physics 1

An introduction to thermodynamics. Fundamental considerations and characteristics of boilers, turbines, internal combustion engines, and compressors.

1. Write the basic laws of thermodynamics and solve selected problems to demonstrate an understanding of the laws.
2. Given the specifications and operating conditions of an internal combustion engine (or compressor or turbine), determine the efficiency.

MET 130 Production Quality Control (2)

2 hours lecture
Prerequisite: MET 21; MET 110 recommended (may be taken concurrently)

An introduction to production planning and quality control techniques and procedures; work methods analysis; selection of inspection methods and equipment.

1. Given the specifications of a part and a description of the manufacturing procedures involved in producing the part, list and describe appropriate quality assurance techniques including inspection devices and procedures.
2. Given sufficient information describing the manufacturing procedures for mass producing a part, describe the techniques and procedures to establish statistical quality control for the process. A calculator and reference material may be used.

MET 140 Introduction to Numerical Control (3)

2 hours lecture, 3 hours laboratory
Prerequisite: MET 21 or MIT 15

Instruction in numerical control machine tool systems. Fundamentals of programming and use of numerical control of machine tools. Includes manual programming, tape formats, preparation of tapes, and operation of numerically controlled machine tools.

1. Write a report describing several types of numerical control machine tool systems. Include an analysis of the advantages and limitations of each system.
2. Given the design specifications (a working drawing) of a plastic (or metal) part, write the program, prepare the tape, and make an accurate sample part using a numerical controlled milling machine.

MET 150 Vacuum Technology (3)

2 hours lecture, 3 hours laboratory
Prerequisite: MET 23

Basic theory of vacuum systems. The performance characteristics of vacuum pumps, measurement devices, and other components of vacuum systems. Procedures and techniques in the use of vacuum apparatus.

1. Given a schematic representation of a typical vacuum system, list and describe the function of each component of the system.
2. Given the components of a conventional vacuum system, appropriate tools and measuring devices, assemble the components and operate the system to achieve a vacuum in specified increment values. Record the values of pressure (vacuum) by using Bourdon, liquid level, and thermal conductivity vacuum gages.
3. Locate a leak in an operating vacuum system by using a halogen leak detector and perform the necessary repairs to eliminate the leak.

MET 200 Special Projects (2-4)

1 hour consultation, 3 hours laboratory per unit
Prerequisite: Consent of instructor

Individual instruction is provided to enable the student to work on special projects and/or study selected topics not covered by scheduled course offerings.

1. Demonstrate the project and/or write a report including documentation of the project.

MET 300 Work Experience

Units and hours by arrangement
Prerequisite: Enrollment in MET curriculum

Credit for supervised coordinated work experience in industry which contributes to the attainment of the student's vocational objective. It is recommended that work experience units not be substituted for required technical courses.

Descriptions of the following courses can be found on pages indicated:

MIT 12 see page 69
MIT 14 see page 69
MIT 110 see page 73
MIT 170 see page 74

5. EMPLOYMENT OPPORTUNITIES

a) Students who satisfactorily complete the first year's work in the curriculum, including appropriate elective course work, may qualify for employment as a:

Mechanical Engineering Assistant I
  (San Francisco Civil Service)
Junior Mechanical Technician
Mechanical Inspection Technician
  (Junior Grade)
Junior Mechanical Draftsman
Other similar jobs in the mechanical
  and manufacturing fields

b) Those students who successfully complete the curriculum in Mechanical Engineering Technology may qualify for employment as mechanical engineering technicians with firms and government agencies involved in manufacturing, design, and research and development. Large numbers of mechanical engineering technicians are employed by firms engaged in research and development activities. Job classifications/titles include:

Mechanical Engineering Aide
Accelerator Technician
Production Technician
Quality Assurance Technician
Machine (Mechanical) Design Technician
Vacuum Technician
Maintenance Technician

Mechanical Engineering Assistant II
(San Francisco Civil Service)
Non-destructive Test Technician
Thermophysical Laboratory Technician
Materials Evaluation Test Technician
Research Technician
Refrigeration Technician
Operating Engineering Assistant

Specific employment capabilities will depend upon the technical electives selected by the student.

C. MECHANICAL INDUSTRIAL TECHNOLOGY

1. CURRICULUM PREREQUISITE

A minimum curriculum prerequisite should be established for this program. General high school mathematics or reasonable proficiency in arithmetic operations, determined by a qualifying score on a mathematics placement test, is the recommended curriculum prerequisite. This prerequisite is based on the supposition that adequate instruction in mathematics and physics will be integrated into the technical course work. An alternative would be to include additional courses in these disciplines in the curriculum.

2. CORE CURRICULUM (SUGGESTED SEQUENCE)

The introductory remarks of this section on mechanical technology indicated the diverse composition of mechanical industrial technology programs. Input from industry reveals a similar diversity of "mechanical-related" technician categories. The core curriculum presented in this guide is at best a compromise to provide two semesters of fundamental course work and allow maximum latitude for specialization. The technical elective courses which have been included should qualify the graduate for employment opportunities in air conditioning and refrigeration, manufacturing, mechanical maintenance and repair, and related fields. It is acknowledged that additional technical electives could (should) be added. Perhaps a subsequent revision of this guide can be expanded to be more comprehensive.

MECHANICAL INDUSTRIAL TECHNOLOGY

(AS Degree Curriculum)

Suggested Sequence

First Semester:

(1)Drafting A	Fundamentals of Mechanical Drawing	3
Math IT-1	Industrial Mathematics	4
MIT 11	Basic Machine Shop	3
MIT 13	Welding Fundamentals	3
Technology 10	Occupational Safety and Health	2

Second Semester:

MIT 12	Advanced Machine Shop Practices	3
MIT 14	Advanced Welding Practices	3
MIT 15	Manufacturing Processes and Materials	2
MIT 16	Thermofluid Measurements	3
Tech. English 1	Communication Skills and Report Writing	3
*Electives		

Third Semester:

MIT 21	Inspection Techniques and Devices	3
*Electives		

Fourth Semester:

Technology 20	Human and Industrial Relations	2
*Electives		

*Electives should be selected to fulfill graduation requirements and provide technical elective courses. A minimum of 12 semester units of technical elective courses should be selected by the student in consultation with the Curriculum Technical Advisor, or Counselor, to satisfy the student's occupational objective.

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(1) Not required of students who have completed one year of high school mechanical drawing. (Drafting 1 is recommended for these students.)

3. TECHNICAL ELECTIVES

Selection of appropriate technical electives from the courses listed below will provide greater depth and specialized knowledge and skills for specific employment opportunities.

MIT 110	Tool and Die Design	(4)
MIT 120	Production Machining	(3)
MIT 130	Production Welding	(4)
MIT 140	Inspection and Quality Control	(3)
MIT 150	Numerical Control Machining	(4)
MIT 160	Introduction to Physical Metallurgy	(4)
MIT 170	Fundamentals of Refrigeration Systems	(4)
MIT 180	Air Conditioning, Heating and Ventilation	(4)
MIT 200	Special Projects	(1-4)
MIT 300	Work Experience	
Drafting 1	Fundamentals of Technical Drafting	(3)
EIT 11	Introduction to Electronics	(5)
(1)Mathematics A	Fundamentals of Technical Mathematics	(4)
(1)Physics A	Elementary Physics	(3)

4. COURSE DESCRIPTIONS

(CORE CURRICULUM COURSES)

MIT 11 Basic Machine Shop (3)

1 hour lecture, 6 hours laboratory
Prerequisite: None

Basic machine tool practice; operation of the lathe, milling machine, drill press, and shaper; care and use of measuring instruments and hand tools. Emphasis on shop safety practices.

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(1) These courses should be included in the curriculum core if adequate instruction in mathematics and physics is not integrated into technical course work.

1. Given a written or oral set of questions on shop safety, recite and demonstrate proper procedures for safe operation of basic machine and hand tools used in the course.
2. Given any measuring instrument such as a micrometer used in the course, recite and demonstrate the proper use and care of the instrument.
3. Given the necessary specifications of an assembly of parts (a simple course project), perform the required hand tool and machining operations (turning, drilling, milling, filing) to make and assemble the parts.

MIT 12 Advanced Machine Shop Practice (3)

1 hour lecture, 6 hours laboratory
Prerequisite: MIT 11

Theory and practice involving more complex machining processes, including precision grinding in addition to lathe and milling operations; instruction in machine tool maintenance.

1. Given complete specifications for a part, make the part using the lathe, milling machine, and precision grinding equipment holding specified dimensions to a tolerance of ± 0.0005 inches.
2. Given appropriate manufacturers' literature, identify and perform the suggested preventative maintenance for a machine tool.
3. Given the specifications for a gear and rack, machine the parts and demonstrate that the parts function properly.

MIT 13 Welding Fundamentals (3)

6 hours of lecture-laboratory
Prerequisite: None

Instruction and practice in oxy-acetylene welding, flame cutting, and electric arc welding. Emphasis on shop safety practices.

1. Correctly answer all questions on a safety test without using reference material and demonstrate proper safety procedures in the welding laboratory.
2. Given the required material and equipment, butt weld two steel plates using an electric arc and perform a tensile test on the welded parts. The weld strength should not be less than 70% of the strength of the material of the parts.
3. Without references, list at least two applications where it would be advantageous to use oxy-acetylene welding, electric arc welding, and MIG or TIG welding.

MIT 14 Advanced Welding Practices (3)

1 hour lecture, 6 hours laboratory
Prerequisite: MIT 13

A continuation of MIT 13 to develop increased welding skills, including position welding, welding and brazing of a variety of ferrous and non-ferrous metals, and TIG welding.

1. Demonstrate the skills and knowledge required to perform vertical and overhead welding.
2. Demonstrate the skill and knowledge required to join two aluminum parts and also two stainless steel parts. Selection of the appropriate welding process and methods are the student's responsibility.

MIT 15 Manufacturing Processes and Materials (2)

2 hours lecture
Prerequisite: MIT 11; MIT 13 recommended

Introduction to mass production manufacturing processes, including machining, forging, extruding, powder metallurgy, furnace brazing and soldering, welding. Physical properties of materials and the effect of those properties on forming processes.

1. Given the specifications of a set of parts identify the mass production processes which could be used to economically make the parts.

MIT 16 Thermofluid Measurements (3)

6 hours of lecture-laboratory
Prerequisite: Mathematics IT-1

Elementary concepts and methods of measuring pressure, temperature, and fluid flow. Practical applications with emphasis on use of measuring devices and procedures for obtaining measurements.

1. Given the required equipment, tools, and instructions, set up a refrigeration cycle and measure required temperature changes and flow rates at specified points.
2. Given a pump and a closed piping system, manufacturers' literature on the pump, and necessary instructions, measure the flow rate and velocity of the fluid at specified points using several types of measuring devices. Record and compare the results obtained from the different devices.

MIT 21 Inspection Techniques and Devices (3)

2 hours lecture, 3 hours laboratory
Prerequisite: Mathematics IT-1 and MIT 12

Basic theory and application of precision tools, measuring instruments, gaging devices, and inspection techniques.

1. Given a list of machining and welding operations and the acceptable quality standards, describe the inspection methods and measuring instruments and gages which could be used to verify the acceptability of the products.
2. Given the necessary measuring instruments and gages, check a sample of parts to determine if they meet the prescribed quality standards.

Drafting A Fundamentals of Mechanical Drawing (3)

6 hours lecture-laboratory
Prerequisite: None

Use of drawing instruments; geometric constructions and basic concepts of orthographic drawing and sketching.

Math IT-1 Industrial Mathematics (4)

3 hours lecture, 2 hours problem-solving sessions
Prerequisite: Qualifying score on mathematics placement test

A review of arithmetic fundamentals; basic mathematics for industrial use, including an introduction to the fundamental concepts of algebra, geometry, and trigonometry. Use of calculators; metric system of units and measure. Concepts and techniques are introduced in the lectures; exercises and practical applications relative to the student's curriculum are provided in the problem-solving sessions. (This course is primarily designed for those students entering vocational or industrial technology programs.)

1. Solve assigned problems to demonstrate an acceptable level of proficiency and knowledge of fractions, decimals, percentages, ratios and proportions.
2. Given a regular geometric shape and appropriate dimensions, solve the algebraic equation for the area or volume.
3. Given a binomial, solve the expression for any of the literal numbers.
4. Given two sides, or an angle and one side, of a right triangle, solve for the angle(s) and/or the sides of the triangle.

Technical English 1 Communication Skills and Report Writing (3)

2 hours lecture, 2 hours laboratory-conference
Prerequisite: Qualifying score on English placement test

Instruction and practice in communication of both oral and written information. Emphasis on techniques for writing various types of technical communication and reports. Assistance with the writing of laboratory reports is provided during the laboratory-conference sessions.

1. List and describe the three frames of reference from which a mechanism, or electronic device, may be described.
2. Write a suitable topic sentence (generalization) which can be developed by five or more supportive statements, joined coherently.
3. Plan and write a report based on experimental data collected in a laboratory course; also prepare an outline and deliver an oral presentation on the report subject.

Technology 10 Occupational Safety and Health (2)

2 hours lecture
Prerequisite: None

Employer and employee responsibility, Federal and State legislation, accident reports, industrial hygiene, personal protective equipment, materials handling and storage, guarding machines and mechanisms, hand and portable power tools, fire prevention.

1. State the steps that should be taken if a person with whom you were working became paralyzed from electrical shock.
2. List at least five safety precautions to be observed when working with any type of rotating machinery.
3. List at least five safety precautions to be observed when working with electrical circuits.

Technology 20 Human and Industrial Relations (2)

2 hours lecture
Prerequisite: Technical English 1 (or equivalent) and sophomore standing

Presents the historical, philosophical, and social bases for human relations. Case studies are used to emphasize the responsibilities of supervisors and subordinates in industrial (labor) relations.

1. Describe the principles of human relations and explain how and why these principles were derived.
2. Apply the principles of human relations to illustrate how these principles can be applied to resolve problems which may occur between workers, supervisors, and management.

(TECHNICAL ELECTIVE COURSES)

MIT 110 Tool and Die Design (4)

2 hours lecture, 6 hours laboratory
Prerequisite: MIT 12 and MIT 15

Theory and practice in design and construction of shearing, forming, and progressive dies. Fabrication of tools, jigs, and fixtures for the production of components made with dies.

1. Given complete specifications of a part, design the tooling and make the set of progressive dies, jigs, and fixtures required to form the part. Run off several parts to check the die design.

MIT 120 Production Machining (3)

2 hours lecture, 3 hours laboratory
Prerequisite: MIT 12, MIT 14, and MIT 15; concurrent enrollment in MIT 140 recommended; consent of instructor

A project type course, which allows the students to plan, set-up, and carry out a production line process. All phases of manufacturing from material selection, tooling, inspection, and assembly are included.

MIT 130 Production Welding (4)

2 hours lecture; 6 hours laboratory
Prerequisite: MIT 14

Factors affecting weld design; cost of materials, strength requirements, and function of weldments. Laboratory exercises support lecture presentation and provide additional experience in welding techniques, including TIG and MIG welding.

1. Given a weldment design with functional specifications, identify the proper weld specifications and procedures which should be used to make the part. Write a materials list and a cost analysis. Make the part in the laboratory, then compare the product with the specifications (given and derived) and the actual cost with the computed cost.

MIT 140 Inspection and Quality Control (3)

3 hours lecture and field trips as required
Prerequisite: MIT 14 and MIT 15; MIT 21 and Mathematics A recommended

Philosophy and implementation of quality control and inspection techniques used in industry.

1. Given a specific product (including specifications) and the manufacturing processes used to make the product, list at least five major considerations which should be taken into account to set up adequate quality control, also list the inspection techniques and devices which should be used to check the quality of the product.
2. From information obtained by observing a manufacturing process (on a field trip), write a report listing the quality control and inspection methods used.

MIT 150 Numerical Control Machining (4)

2 hours lecture, 3 hours laboratory
Prerequisite: Math. IT-1 and MIT 12

Evolution of numerical control machine tools; numerical control systems. Instruction and practice in programming and operation of numerical control machine tools.

1. Given the specifications of a part and the tape program required to make the part, set up and operate the NC machine tool to produce the part. Check the part against the specifications and evaluate the accuracy of the program.

MIT 160 Introduction to Physical Metallurgy (4)

3 hours lecture, 3 hours laboratory
Prerequisite: MIT 12, MIT 14 and MIT 15

A study of mechanical testing, metal structure, metallurgical examination, ferrous and non-ferrous specimens. Heat treatment and testing techniques are included in laboratory exercises.

1. Given several ferrous and non-ferrous metal specimens, conduct the appropriate tests to determine the tensile strength of the materials; compare the results with reference data.
2. Given several alloy steel specimens of a known ASTM (SAE or other) specification, test and record the hardness of an untreated specimen and compare the results with specimens which have been heat-treated according to varied specified conditions.

MIT 170 Fundamentals of Refrigeration Systems (4)

3 hours lecture, 3 hours laboratory
Prerequisite: MIT 16, Mathematics A recommended

A study of the refrigeration cycle, cooling loads, refrigerants, and controls. Laboratory exercises include operating and test procedures, related safety practices.

1. Given a refrigeration system and appropriate test equipment, determine the cooling loads for various specified conditions, also determine the maximum cooling load capacity of the system.
2. Given a compressor, appropriate specifications, and test instruments, determine the capacity and volumetric efficiency of the compressor.
3. Define and discuss the effect of superheating, subcooling, and pressure losses in refrigeration systems.

MIT 180 Air Conditioning, Heating & Ventilation (4)

3 hours lecture, 3 hours laboratory
Prerequisite: MIT 16 or MET 23

Instruction in the basic elements of air conditioning, including cooling loads, heat transfer, air handling equipment, and design of air conditioning systems. Laboratory work involves use of measuring equipment and application of control systems.

1. Describe the psychrometric process and explain its significance in air conditioning and heating systems.
2. Given the specifications of (or an actual) system of ducts, calculate theoretical pressure losses in the system (or use appropriate test equipment to measure the pressure losses).
3. Describe the function of a heat pump and list the advantages and limitations of the device.
4. Given a set of air conditioning problems which require the use of psychrometric tables and/or charts to arrive at the solution, demonstrate an understanding of the use of these tools by solving the problems.

MIT 200 Special Projects (1-4)

Hours by arrangement
Prerequisite: Consent of instructor

Individual instruction is provided to enable the student to work on special projects and/or study selected topics not covered by scheduled course offerings.

MIT 300 Work Experience

Units and hours by arrangement
Prerequisite: Enrollment in MIT curriculum

Credit for supervised coordinated work experience in industry which contributes to the attainment of the student's vocational objective. It is recommended that work experience units not be substituted for required technical courses.

Drafting 1 Fundamentals of Engineering Drafting (3)

6 hours of lecture-laboratory
Prerequisite: High school mechanical drawing recommended

Fundamentals of orthographic projection and descriptive geometry as applied to engineering drawings.

1. Given a model, or a pictorial drawing, of a part, demonstrate an understanding of geometric construction and orthographic projection by accurately drawing the views required to describe the part.
2. Demonstrate an understanding of the fundamentals of descriptive geometry by solving problems requiring the determination of true length of a line, true shape of a plane, and the distance between a point and a plane.

EIT 11 Introduction to Electronics (5)

3 hours lecture, 6 hours laboratory
Prerequisite: Mathematics IT-1 (or equivalent), may be taken concurrently

Fundamentals of electricity and magnetism, including DC and AC passive circuits. Introduction to basic electronic components and circuit applications. Laboratory exercises are designed to supplement lecture presentations and to familiarize the student with the use of instruments and measuring techniques.

1. Analyze series DC circuits by finding values for all unknown voltages, currents, powers and resistances when given the schematic and sufficient information about the remaining components.
2. Given the values of any two Ohms' law variables, determine the third.
3. Given either a resistor, a capacitor or an inductor with rated values and tolerance, use suitable test equipment to determine if the device is within tolerance.

Math. A Fundamentals of Technical Mathematics (4)

3 hours lecture, 2 hours problem solving session
Prerequisite: One year high school algebra (or equivalent or a qualifying score on placement test

A brief review of basic arithmetic operations and elementary algebra. Instruction in the fundamentals of algebra, geometry, and right-angle trigonometry with emphasis on problem-solving techniques as applied to typical problems encountered in technology curriculums. Use of computational devices (calculators).

Concepts and techniques are introduced in the lectures; exercises in practical applications and individual tutoring are provided in the problem-solving sessions. (This course is designed to accommodate remedial requirements and satisfy the prerequisite requirements for mathematics courses in the engineering technology curriculums. The course may also serve to increase the mathematical competency of students enrolled in industrial technology curriculums.)

1. Given a quadratic equation, solve for the unknown variable.
2. Given two independent linear equations with two unknowns, solve for the unknown variables.
3. Given a right triangle with two sides, (or an angle and one side) known, solve for the unknown angles and sides by using trigonometry.
4. Given the resultant vector, resolve that vector into its X and Y components; also given the X and Y components determine the resultant vector.

Physics A Elementary Physics (3)

2 hours lecture, 3 hours conference/demonstrations
Prerequisite: Mathematics A or equivalent (Mathematics A may be taken concurrently)

A preparatory course for students who have had no previous experience in physics. Emphasis is on solving problems involving forces, energy, elementary kinematics, fluids, and electricity. (This course is designed to meet the matriculation (remedial) requirements for Physics 1 or 11.)

5. EMPLOYMENT OPPORTUNITIES

a) Students who successfully complete the first year's work in the curriculum, including appropriate electives, may qualify for employment as follows:

Machine Tool Operator
Welder's Helper
Maintenance Technician (Mechanic)
Junior Mechanical Draftsman
Inspection Aide
Other similar jobs in the mechanical and manufacturing fields.

b) A student who satisfactorily completes the Mechanical Industrial Technology Curriculum may qualify for positions in industry, including such job classification/titles as follows:

Mechanical Technician
Manufacturing Technician (Junior Grade)
Machinist Helper (Starting machinist)
Mechanical Inspection Technician
Maintenance Technician
Air Conditioning/Refrigeration Technician
Welding Technician
Production Planning Aide
Refrigeration Serviceman
Tool Design Machinist Aide
Numerical Control Machine Tool Operator
Methods and Processes Technician--Junior Grade

The specific employment capabilities of the graduate will depend upon his selection of technical electives in the program.

ELECTRO-MECHANICAL ENGINEERING TECHNOLOGY

This section will include course and curriculum recommendations for Electro-Mechanical Engineering Technology.

A. INTRODUCTION AND EDUCATIONAL OBJECTIVES

B. CURRICULUM PREREQUISITE

C. CORE CURRICULUM (Suggested Sequence)

D. COURSE DESCRIPTIONS
   1) Core Courses
   2) Technical Elective Courses

E. EMPLOYMENT OPPORTUNITIES

F. COMMENTS

A. INTRODUCTION AND EDUCATIONAL OBJECTIVES

Before proceeding with the specifics and outline of the curriculum content, it seems worthwhile to present some historical facts about the development of this dual-discipline program.

It would be difficult to overstate the contribution made by the Technical Education Research Centers (TERC). In a project authorized and funded by the U.S. Department of Health, Education and Welfare, TERC undertook the research and development work required to identify the need and establish the basic frame of reference for this emerging curriculum.(1)

Data from a survey conducted by TERC indicated that the need for electro-mechanical technicians would exceed that of all other technician classifications in the forseeable future. A great deal of evidence has become available subsequent to the survey to support that conclusion. How often we hear an employer comment, "He is a top-notch electronics technician, but a simple mechanical problem stops him cold," or "He is an excellent mechanical technician, but he has little or no ability to solve a simple electronics problem." Certainly industry has loudly expressed the need for electro-mechanical technicians--but where is the supply?

Very few California Community Colleges offer an electro-mechanical curriculum (three, based on a study by the project director). This statement may seem to conflict with the data from Questionnaire B (see page 49), which shows nine (IT) programs and six (ET) programs in "mechanical-electrical"; however, the footnote explains this apparent discrepancy. A mechanical-electrical curriculum is not necessarily electro-mechanical.

Electro-mechanical is indeed a contraction of electrical-electronics-mechanical; however, the curriculum is not simply a selected conglomerate of electrical, electronics, and mechanical courses. On the contrary, it is a logical sequence of courses with concurrent applications in electricity, mechanics, physics, and mathematics. Electro-mechanical engineering technicians are, in a real sense, systems technicians capable of dealing with complex industrial equipment and machinery that incorporate mechanical, hydraulic, pneumatic, electronic, optical, and thermal devices. As educators in the field of technical education we know well how difficult it is to provide an adequate background in a single discipline by a conventional curriculum structure in the short span of two years. How then can we hope to take pieces of these conventional curriculums and achieve a quality dual-discipline educational program? The answer is we cannot use conventional methodology.

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(1) Detailed information about this project is presented in Electro-mechanical Technology, Final Report, Project No. 8-0219, Technical Education Research Center, P.O. Box 4395, Waco, Texas 76705.

The educational objective of the Electro-Mechanical Engineering Technology curriculum is to provide instruction which will enable the student to understand and apply the fundamental concepts of, and interrelationships among, electronics, mechanics, hydraulics, and thermodynamics in practical engineered devices and systems. The topical vehicle for developing this background is energy--its storage and transfer.

In order to achieve this ambitious objective it is essential that the first-year course work must be carefully structured and the presentation of courses must be highly coordinated. To accomplish this, a cooperative effort of the highest order is required from the faculty teaching concurrent courses. These necessary elements are difficult to achieve and sustain; therefore, it is not a simple task to develop a quality electro-mechanical curriculum. However, the product of this effort can be extremely rewarding.

It will be noted that the curriculum outline provides minimal opportunity for elective courses. This is an unfortunate circumstance associated with the demanding requirements of a core curriculum which will fulfill the educational objective of the Electro-Mechanical Engineering Technology curriculum.

B. CURRICULUM PREREQUISITE

The recommended curriculum prerequisite is satisfactory completion of high school trigonometry, a course in mechanical drawing, and a course in general science or physics.

The minimum prerequisite is intermediate algebra (equivalent competency in algebra), a course in mechanical drawing, and a course in high school general science (or equivalent).

C. CORE CURRICULUM (SUGGESTED SEQUENCE)

The following outline and suggested sequence of courses is designed for students who have satisfied the minimum curriculum prerequisite. Students who are deficient in prerequisite requirements should complete the remedial course work to remove the deficiencies before enrolling in the first semester of the Electro-Mechanical Engineering Technology curriculum. A primary criterion for successful implementation of the curriculum is that the student enroll in the basic group of core courses in the first semester: EMT 11, MET 12, Math 1, and Physics 11. Therefore, it is highly recommended that a semester of pre-Electro-Mechanical Engineering Technology course work be available for students with deficiencies (see Appendix IV for descriptions of remedial courses).

ELECTRO-MECHANICAL ENGINEERING TECHNOLOGY

(AS Degree Curriculum)

Suggested Sequence

First Semester:

EMT 11	Introduction to Electricity, D.C.	2
MET 11	Metal Cutting Processes	2
MET 12	Mechanisms I	2
English R	Technical Report Writing	1
Math. 1	Applied Technical Mathematics	4
Physics 11	Unified Physics I	3
*Electives		

Second Semester:

EMT 12	Introduction to Electricity, A.C.	2
MET 13	Materials	2
MET 22	Mechanisms II	2
Math. 2	Advanced Technical Mathematics	3
Physics 12	Unified Physics II	3
Tech. Engl. 1	Communication Skills & Report Writing	3

Third Semester:

Drafting 1	Fundamentals of Engineering Drafting	3
EET 13	Introduction to Digital Electronics	3
EMT 21	Electrical Machines & Controls	3
EMT 22	Electro-mechanical Devices & Instrumentation	3
*Electives		

Fourth Semester:

Computers 1	Basic Programming Techniques	3
EMT 23	Electro-mechanical Controls, Devices & Systems	4
EMT 24	Industrial Electronics	3
Technology 20	Human and Industrial Relations	2
*Electives		

*Electives should be selected to fulfill graduation requirements and provide technical elective courses. A minimum of 6 semester units of technical elective courses should be selected by the student in consultation with the Curriculum Technical Advisor, or Counselor, to satisfy the student's occupational objective.

D. COURSE DESCRIPTIONS

(CORE CURRICULUM COURSES)

Computers 1 Programming Techniques (3)

2 hours lecture, 2 hours conference/laboratory
Prerequisite: Mathematics 1

Introduction to BASIC and FORTRAN programming languages; use of computers for the solution of engineering problems.

Drafting 1 Fundamentals of Engineering Drafting (3)

6 hours of lecture-laboratory
Prerequisite: High school mechanical drawing (or equivalent)

Fundamentals of orthographic projection and descriptive geometry as applied to engineering drawings.

1. Given a model, or a pictorial drawing, of a part, demonstate an understanding of geometric construction and orthographic projection by accurately drawing the views required to describe the part.
2. Demonstrate an understanding of the fundamentals of descriptive geometry by solving problems requiring the determination of true length of a line, true shape of a plane, and the distance between a point and a plane.

EET 13 Introduction to Digital Electronics (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EET 11 and EET 11L, or EMT 11 and EMT 12

Theory and measurements of digital and logic circuits, operational amplifiers, and analog/digital circuits and systems; emphasis is on integrated circuits.

1. Given a diagram consisting of AND gates, OR gates, and inverters, draw a truth table.
2. Design and contruct an astable multivibrator using bipolar transistors for a given frequency.
3. Using J-K flip-flops, build a modulo six counter and analyse its operation using appropriate test equipment.

EMT 11 Introduction to Electricity, D.C. (2)

1 hour lecture, 3 hours laboratory
Prerequisite: Mathematics 1 and Physics 11 (may be taken concurrently)

Instruction in the fundamentals of electricity using passive and active devices in D.C. circuits; techniques of measurements.

1. Given any two of the values for voltage, current, and/or resistance, use Ohm's law to solve for the unknown value.
2. Given a series or parallel circuit, values of input current and voltage, and known resistance values, solve for the output current and voltage.
3. Given a DC circuit, a voltmeter, ammeter, and ohmmeter, perform the necessary measurements to determine the values of current, emf, and resistance for specified points in the circuit.

EMT 12 Introduction to Electricity, A.C. (2)

1 hour lecture, 3 hours laboratory
Prerequisite: EMT 11

Instruction in the fundamentals of electricity and magnetism using passive and active devices in both DC and AC circuits; techniques of measurements.

1. Demonstrate an understanding of Faraday's law, Lenz's law, and B-H curves by solving assigned problems involving magnetism and induced emf.
2. Given a schematic of a series or parallel circuit which includes resistance, inductance, and capacitance, two of which have known values, calculate the unknown value. Construct the circuit in the laboratory--verify the calculated value of the unknown and the resonance frequency of the circuit using appropriate instrumentation.
3. Given an amplification circuit which includes a transistor, select appropriate instrumentation, obtain data, and plot a graph to illustrate the amplification characteristics. Write a description of amplification characteristics using mechanical and fluid systems to illustrate the definition (reference "unified physics" concepts).

EMT 21 Electrical Machines and Controls (3)

2 hours lecture, 3 hours laboratory
Prerequisites: EMT 11 and EMT 12 (or equivalent)

A study of alternating- and direct-current power equipment, including motors, generators, converters, transformers, and controls.

1. Given an AC or DC motor (or generator) and the required auxiliary components and instrumentation, design the circuit, connect the components, and perform all tests required to verify proper function of the system. Explain the operating characteristics of the motor.
2. Given a three-phase motor installation, draw a schematic diagram of the control and circuit wiring and describe (explain) the function of all components.
3. Given an AC or DC power source and specified power requirements to operate a component, identify and describe the specifications of the transformer, converter, and/or other devices required to achieve the required conversion.

EMT 22 Electro-mechanical Devices and Instrumentation (3)

2 hours lecture, 3 hours laboratory
Prerequisite: EET 13 and EMT 21 (may be taken concurrently)

Instruction in practical electronic circuits, basic electro-mechanical and electro-optical transducers and auxilliary devices; an introduction to electro-mechanical instrumentation systems.

1. Given a basic electro-mechanical device (and/or an electro-optical device) and appropriate test equipment determine the transfer characteristics of the device(s) and write a report describing the test results.
2. Demonstrate an understanding of a given electro-mechanical instrumentation system by performing specified tests and calibrations. Manufacturer's literature and other reference materials may be used.

EMT 23 Electro-mechanical Control Devices and Systems (4)

2 hours lecture, 6 hours laboratory
Prerequisite: EMT 22 (or consent of instructor)

A study of electro-mechanical control devices and instrumentation; open loop and closed loop control including the concepts of stability and compensation in feedback systems.

1. Given a real or hypothetical linear electro-mechanical system, use appropriate test equipment and manufacturers' literature to determine the transfer characteristics of the components of the system.
2. Given the transfer characteristics of the components of a linear feedback system, construct a Bode Plot for the loop gain and use it to predict stability.
3. Given a system with one or more faulty components, make appropriate tests and measurements to isolate the faulty component(s).

EMT 24 Industrial Electronics (3)

1 hour lecture, 6 hours laboratory (field trips)
Prerequisite: EMT 22

A study of electronic devices and their applications in industrial electro-mechanical systems; electro-mechanical fabrication. Practical industrial applications of automated controls and instrumentation are stressed.

1. Given a schematic of a silicon controlled rectifier (SCR) circuit, describe the operational sequence of events which occur in the circuit.
2. Given input and output specifications and the components, materials, and test instruments, design and fabricate an electo-mechanical device (system) which will perform the required operation.

3. Given the appropriate schematics and drawings of an electromechanical device, such as a card sorter, identify and describe the function of the electronic circuits and the mechanical components.

MET 11 Metal Cutting Processes (2)

1 hour lecture, 3 hours laboratory
Prerequisite: None

Instruction in principles and applications of metal cutting. Laboratory experience in the operation of basic lathe and milling machine; drill press, off-hand grinder, and hand tools. Emphasis on shop safety practices.

1. Indicate a sufficient appreciation of shop safety practices by answering all questions correctly on a shop safety test and demonstrate proper safety practices in the laboratory.
2. Given the specifications for a simple part, perform the machining operations using a lathe, drill press, and milling machine. Satisfactory performance will include attainment of some dimensions to a tolerance of ± 0.001 inches.

MET 12 Mechanisms I (2)

4 hours lecture/laboratory
Prerequisite: Mathematics 1 and Physics 11 (may be taken concurrently)

An introductory course in mechanisms; gears, levers, cams, and combination mechanical drives. Instruction in basic concepts of statics.

1. Given various mechanisms which include gears, cams, and levers, identify and list each component and describe the function of the component relative to the operation of the mechanism.
2. Given a mechanism including a gear train and levers, experimentally determine and analytically solve the relationship between input and output in terms of displacement, velocity, and torque (or moment).
3. Given a mechanism in static equilibrium, sketch free-body diagrams of and determine the forces acting on the assigned parts.

MET 13 Materials (2)

2 hours lecture
Prerequisite: Physics 11; MET 11 (or equivalent)

Properties of materials and the influence of these properties on engineering use of the materials.

1. Without the use of reference material, list and describe at least four properties of materials. Materials may be ferrous or non-ferrous metals, or plastics.

2. Given a set of design conditions, identify and compare the properties of various metals and non-metals which would satisfy the property requirements of the design conditions. Reference sources may be used.

MET 22 Mechanisms II (2)

4 hours lecture/laboratory
Prerequisite: MET 12; Mathematics 2 is recommended

A study of kinematics and kinetics applied to mechanisms; cams, linkages, couplings, brakes, clutches, and drives.

1. Given the necessary equipment and specifications, construct a multiple cam timing mechanism and perform the necessary tests to check-out the operation of the mechanism. Test results must agree with the specifications within ± 2%.
2. Given the relationship of time and one of three variables (displacement, velocity, or acceleration), construct the motion diagrams to determine the values of the unknown variables. Either rectilinear or curvilinear (rotation) motion may be involved.
3. Given a rotating mechanism for which the mass of the rotating member and the angular velocity can be varied, determine the kinetic energy of the mechanism for varying values of mass and angular velocity. Report the results in both Egs. and SI units.

Technology 20 Human and Industrial Relations (2)

2 hours lecture
Prerequisite: Technical English 1 (or equivalent) and sophomore standing

Presents the historical, philosophical, and social bases for human relations. Case studies are used to emphasize the responsibilities of supervisors and subordinates in industrial (labor) relations.

1. Describe the principles of human relations and explain how and why these principles were derived.
2. Apply the principles of human relations to illustrate how these principles can be applied to resolve problems which may occur between workers, supervisors, and management.

English R Report Writing for Technicians (1)

1 hour lecture-conference
Prerequisite: Concurrent enrollment in an engineering technology laboratory course.
(Only grades of Credit and No-Credit are given for this course)

Instruction in and assistance with the writing of laboratory reports. Emphasis on organization and preparation of reports, giving special attention to improving techniques of communication.

1. Without references, list and describe the parts (entities) which should be included in a comprehensive laboratory report.
2. Given the required information and data obtained from a laboratory exercise performed in a current course, organize and and write a report on the exercise in accordance with the required format and techniques.

Math 1 Applied Technical Mathematics (4)

3 hours lecture, 2 hours problem-solving session
Prerequisite: Intermediate algebra (Mathematics A or equivalent is recommended); concurrent enrollment in Physics II

A brief review of geometry; fundamentals of trigonometry. Instruction in graphical and analytical methods and techniques used to solve practical problems involving algebra, geometry, and trigonometry; logarithms, and their applications; use of calculators and other computational devices; SI units and English/metric conversions are included. Theory, problem-solving techniques, and general applications are presented in lectures; treatment of specific problems encountered in concurrent technical course work and other typical engineering problems are included in problem-solving sessions.

1. Given an equation of three or more variables of which one is unknown and the dimensions of the known variables are expressed in non-SI units (the equation is used in the discipline of the student's curriculum objective), perform the necessary dimensional analysis and solve the equation expressing the solution in SI units. A calculator (or slide rule) may be used.
2. Given a coplaner concurrent vector system of three or more vector quantities, calculate and properly express the vector value of the resultant. A calculator (or slide rule) may be used.
3. Given a mensuration problem involving three unknown variables, one of which is an angle expressed in radians, and the neccessary data to establish three independent equations, solve the problem to determine the values for all variables. A calculator (or slide rule) may be used.

Math 2 Advanced Technical Mathematics (3)

2 hours lecture, 2 hours problem-solving session
Prerequisite: Mathematics 1 or 1E

Instruction in applied mathematics including an introduction to the basic concepts of analytic geometry, differential and integral calculus, and statistics; emphasis on applications to problems encountered by the engineering technician. Theory, techniques, and general applications are presented in the lectures; specific applications and problem-solving procedures and techniques are included in the problem-solving sessions.

1. Given a set of problems related to the discipline of the students' curriculum objective, demonstrate proficiency in the use of algebra, geometry and trigonometry by obtaining correct solutions to the problems. A calculator and appropriate reference material may be used.
2. Given a set of data consisting of 30 or more sample values, plot the distribution and calculate the mean and standard deviation for the sample.
3. Given a set of equations including those of a straight line, a parabola, a circle, and an ellipse, construct a graph of each equation to identify the geometric form represented by the equation.
4. Given an equation of the relationship of two variables (such as velocity and time), construct a graph of the equation and solve for the derivative value and integral value for a given set of values of the independent variable. Both graphical and analytical methods should be used.

(1)Physics 11 Unified Physics I (3)

2 hours lecture, 3 hours laboratory
Prerequisite: Concurrent enrollment in Mathematics 1, EMT 11, and MET 11

Instruction in the unified physics concepts of differential forces, resistance, energy storage and transfer. Laboratory exercises illustrate the unified physics concepts presented in the lecture sessions; experiments involve electricity, mechanics, fluids, and heat.

1. Given the unified concepts of force, parameter rate, resistance, capacitance, and inertance as applied to one of four systems (mechanical, fluid, heat or electrical), write analogous examples of the concepts for the other three systems.
2. Given the data required to determine the potential energy or kinetic energy stored in a (mechanical, fluid, heat, or electrical) system, calculate the required energy value and describe an analogous comparison for the other systems.
3. Given the necessary specifications, equipment, and selected instrumentation, experimentally determine (measure) values of forces, parameters, and parameter rates in mechanical, fluid, heat and electrical systems. Write a report comparing the measured values and the analogous relationship of the instrumentation used in the various systems.

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(1) For additional information see Appendix III.

(1)Physics 12 Unified Physics II (3)

2 hours lecture, 3 hours laboratory
Prerequisite: Mathematics 1 and Physics 11

A continuation of Physics 11 with instruction in the unified physics concepts of time constants, impedance, resonance, wave field amplification, feedback and stability. Laboratory experiments involve wave motion, sound, and light.

1. Given mechanical, fluid, and electrical systems that are forced to oscillate, identify the unified concepts of impedance and resonance for the systems; also identify series and parallel systems and differentiate between their contrasting modes of behavior.
2. List similarities and differences between wave phenomena in mechanical and fluid systems and wave phenomenon in electromagnetic radiation.
3. Given the required laboratory equipment and materials, construct lens systems that illustrate the behavior of a microscope, a reflecting telescope, and a refracting telescope.

(TECHNICAL ELECTIVES)

EMT 200 Special Projects (2-4)

1 hour consultation, 3 hours laboratory per unit
Prerequisite: Consent of instructor

Individual instruction is provided to enable the student to work on special projects and/or study selected topics not covered by scheduled course offerings.

1. Demonstrate the project and/or write a report including documentation of the project.

EMT 300 Work Experience

Units and hours by arrangement
Prerequisite: Enrollment in EMT curriculum

Credit for supervised coordinated work experience in industry which contributes to the attainment of the student's vocational objective. It is recommended that work experience units not be substituted for required technical courses.

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(1) For additional information see Appendix III.

EET 120 Computer Electronics (5)

3 hours lecture, 6 hours laboratory
Prerequisite: EET 22 and Computer 1; or consent of instructor
(Computer 1 may be taken concurrently)

The principles and design of logic circuits and systems, with emphasis on control and arithmetic processes in computers. Counter, register, and memory circuits, input and output devices, interface problems. Machine-language programming and troubleshooting on the digital computer.

1. Given a digital counter with one defective component and appropriate test equipment, locate the fault.
2. Given a keyboard, a multiplexed seven-segment display, appropriate integrated circuits and specifications, design and test a digital system which will interface the keyboard with the seven-segment time multiplexed display (read-out).

MET 13L Materials Laboratory (1)

3 hours laboratory
Prerequisite: Concurrent enrollment in MET 13

Laboratory exercices in metallurgy; testing, heat treatment, and mechanical working

1. Perform the necessary tests to determine the hardness and tensile strength of a given set of metallic and non-metallic specimens.
2. For a given set of specifications, conduct the required tests and write a report, including a description of the procedures used, an analysis of the results, and conclusions which are verified by the test data.

MET 23 Fluid Mechanics (3)

2 hours lecture, 3 hours laboratory
(or 3 hours lecture)
Prerequisite: Mathematics 1 and Physics 11

Analysis of problems associated with fluid flow, hydraulics, measurement techniques; pump and fan performance characteristics.

1. Given a hydraulic system (including a pump, an orifice, a venturi, and connecting piping) and appropriate measuring devices and reference material, make the necessary measurements to calculate values of flow velocity and capacity, hydrostatic forces, and pipe line losses at or between given points in the system.
2. Demonstrate an understanding of fluid flow by defining terms and solving problems involving axial fan operation, duct flow, hydraulic gradient, and work and energy interchange.

MET 140 Introduction to Numerical Control (3)

2 hours lecture, 3 hours laboratory
Prerequisite: MET 21 or MIT 15 (or consent of instructor)

Instruction in numerical control machine tool systems. Fundamentals of programming and use of numerical control of machine tools. Includes manual programming, tape formats, preparation of tapes, and operation of numerically controlled machine tools.

1. Write a report describing several types of numerical control machine tool systems. Include an analysis of the advantages and limitations of each system.
2. Given the design specifications (a working drawing) of a plastic (or metal) part, write the program, prepare the tape, and make an accurate sample part using a numerical controlled milling machine.

MET 150 Vacuum Technology (3)

2 hours lecture, 3 hours laboratory
Prerequisite: MET 23

Basic theory of vacuum systems. The performance characteristics of vacuum pumps, measurement devices, and other components of vacuum systems. Procedures and techniques in the use of vacuum apparatus.

1. Given a schematic representation of a typical vacuum system, list and describe the function of each component of the system.
2. Given the components of a conventional vacuum system, appropriate tools and measuring devices, assemble the components and operate the system to achieve a vacuum in specified increment values. Record the values of pressure (vacuum) by using Bourdon, liquid level, and thermal conductivity vacuum gages.
3. Locate a leak in an operating vacuum system by using a halogen leak detector and perform the necessary repairs to eliminate the leak.

E. EMPLOYMENT OPPORTUNITIES

As an emerging curriculum, it should be expected that there would be no large list of job titles such as those existing for other established curriculums included in this publication. In fact, one rarely finds a newspaper ad with the caption, "Wanted-Electro-mechanical Technicians"; however, the job descriptions listed in the ads reveal the need for electro-mechanical capabilities. These ads appear under headings of Technicians, Lab

Technicians, Electronics Technicians, Engineering Technicians, Systems Technicians, etc. For example, the following ad appeared in a Southern California newspaper: Industrial Electronics Technician: "...you will install and maintain electronic systems on Numerical Control machines and other complex industrial equipment." A Bay Area newspaper carried the following ad: Technician: "Immediate opening for individual in digital logic test and troubleshooting techniques to maintain computer and peripherial equipment." These are indeed employment opportunities for graduate Electro-Mechanical Engineering Technicians.

In the July-December, 1975 issue of Career Opportunity Index, Employment Offerings by California Employers (page 46)--13 companies specifically listed the employment classification "Technicians-Electromechanical".

In summary, Electro-Mechanical Engineering Technicians are, in a real sense, systems technicians, especially valuable in the design, installation, and maintenance of complex industrial equipment that incorporates mechanical, hydraulic, electronic, and thermal devices.

F. COMMENTS

1. To develop and sustain a successful EMT program, the administration and faculty must acknowledge the need for a high degree of coordination of courses offered in the first year (particularly in the first semester). Unless provisions are made for such coordinated efforts, it is unlikely that the program will achieve an acceptable degree of success.

2. The key course (hub) of the curriculum structure is the physics course--"Unified Physics". The basic theory and concepts introduced in this course must be reinforced with use and applications in the mathematic and technical course work.

3. An integral part of the instructional methodology, and unified physics approach, is the development of student capability to use Standard International (SI) units. It must be realized that all technical personnel must develop this competency in the near future.

4. Some additional laboratory facilities and equipment will be required to implement the EMT program; however, existing laboratories in many community colleges, with slight modifications, will accommodate a considerable amount of the required course work.

5. Information regarding EMT laboratory facilities, equipment, and costs may be obtained from Technical Education Research Centers, P.O. Box 4395, Waco, Texas 76705.

CIVIL TECHNOLOGY

This section will include course and curriculum recommendations for Civil Engineering Technology and certificate programs in Civil Technology.

A. GENERAL REMARKS

B. CIVIL ENGINEERING TECHNOLOGY
   1) Curriculum Prerequisite
   2) Core Curriculum (Suggested Sequence)
   3) Technical Electives
   4) Course Descriptions
   5) Employment Opportunities

C. CERTIFICATE PROGRAMS

D. COMMENTS

A. GENERAL REMARKS

Programs in Civil Technology offer students training for employment in the fields of construction, structural design and fabrication, transportation, and environmental control. Depending upon the course content of the curriculum, the graduate may qualify for entry positions involving surveying, photogrammetry, map drafting; soil testing; planning, computing, estimating, and preparing specification for civil engineering projects. Employment as technicians or engineering aides include jobs with architects; private consulting and engineering firms; federal, state, county and municipal government agencies; public and private transportation agencies and firms.

In general, occupational programs in Civil Technology fall in two catagories: 1) A two-year associate degree curriculum--"Civil Engineering Technology", and 2) Certificate programs including specialized course work to provide limited skills for employment in the field--for example, surveying. It is not considered practical to offer an industrial technology curriculum in this discipline.

B. CIVIL ENGINEERING TECHNOLOGY

1. CURRICULUM PREREQUISITE

The recommended curriculum prerequisite is satisfactory completion of high school trigonometry (or equivalent) and a course in mechanical drawing.

The minimum prerequisite is intermediate algebra (equivalent competency in algebra) and high school mechanical drawing.

In addition, a desirable supplement for either prerequisite cited above would include a course in high school general science or physics.

2. CORE CURRICULUM (SUGGESTED SEQUENCE)

The following outline and suggested sequence of courses is based upon the minimum curriculum prerequisite. If the

CIVIL ENGINEERING TECHNOLOGY

(AS Degree Curriculum)

Suggested Sequence

First Semester:

CET 11A	Fundamentals of Plane Surveying	3
Drafting 1	Fundamentals of Engineering Drafting	3
Math 1	Applied Technical Mathematics	4
Physics 1	Technical Physics	3
*Electives		

Second Semester:

CET 11B	Engineering Surveys	3
CET 12	Materials	2
CET 14	Civil Drafting	3
Tech. Engl. 1	Communication Skills and Report Writing	3
Technology 10	Occupational Safety and Health	2
*Electives		

Third Semester:

CET 13	Soil Mechanics	3
Computers 1	Programming Techniques	3
*Electives		

Fourth Semester:

*Electives

*Electives should be selected to fulfill graduation requirements and provide technical elective courses. A minimum of 15 semester units of technical elective courses should be selected by the student in consultation with the Curriculum Technical Advisor, or Counselor, to satisfy the student's occupational objective.

recommended curriculum prerequisite is adopted, the first semester course in mathematics may be reduced by one unit, and instruction in mathematics in the technical courses may be minimized. The additional time thus gained may be used to provide greater in-depth instruction in the technical courses. Descriptions of typical remedial courses are included in Appendix IV. These courses are designed to allow the student to remove high school deficiencies and thereby satisfy the recommended curriculum prerequisite.

3. TECHNICAL ELECTIVES

Various options or specialities exist within the field of employment for civil engineering technicians. Some of the more common include:

a) Surveying
b) Structural Design/Civil Drafting
c) Soil Mechanics

Technical electives can be selected to provide the special skills. The letters in brackets [a,b,c] in the right margin indicate the option for which the course is applicable.

CET 110	Mechanics	(3)	[b,c]
CET 120	Strength of Materials	(3)	[b,c]
CET 130	Hydraulics	(3)	[b,c]
CET 140	Topographic Surveying	(4)	[a,b]
CET 150	Route Surveying	(3)	[a]
CET 160	Photogrammetry	(2)	[a,b]
CET 200	Special Projects	(1-5)	[a,b,c]
Chem. 101	Technical Chemistry	(4)	[c]
Draft. 110	Structural Design Drafting	(3)	[b,c]
Math. 2	Advanced Technical Mathematics	(3)	[a,b,c]

4. COURSE DESCRIPTIONS

(CORE CURRICULUM COURSES)

CET 11A Fundamentals of Plane Surveying (3)

2 hours lecture, 3 hours laboratory
Prerequisite: Trigonometry (Mathematics A or equivalent) or concurrent enrollment in Mathematics 1

The principles of elementary plane surveying. Use, care, and adjustment of basic surveying equipment; safety practices; problems in surveying measurements; theory and treatment of errors. Instruction in field and office practice, surveying notes and computations.

CET 11B Engineering Surveys (3)

2 hours lecture, 3 hours laboratory
Prerequisite: CET 11A

Control surveys; topographic mapping, stadia and plane table surveys; horizontal and vertical curves, earthwork; practical field astronomy; introduction to photogrammetry.

CET 12 Materials (2)

2 hours lecture
Prerequisite: High school chemistry recommended

Introduction to the property of materials commonly used in construction and the influence of these properties on design and economic considerations and use of the materials; ASTM, AISI, and other material specifications.

CET 13 Soil Mechanics (3)

2 hours lecture, 3 hours laboratory (or 3 hours lecture)
Prerequisite: None

An introductory course dealing with the principles of engineering geology, physics and mechanics of soils, procedures and techniques of soil testing; instruction in geologic structures and their significance as applied to engineering construction.

CET 14 Civil Drafting (3)

6 hours lecture-laboratory
Prerequisite: CET 11B and Drafting 1 (CET 11B may be taken concurrently)

Computations and procedures peculiar to civil engineering activities; topographic mapping, subdivision and land descriptions, routes and rights-of-way, profiles and cross sections, highway design. Instruction in drafting techniques and the use, adjustment, and care of modern drafting equipment.

Computers 1 Programming Techniques (3)

3 hours lecture, 2 hours conference/laboratory
Prerequisite: Mathematics 1

Introduction to BASIC and FORTRAN programming languages; use of computers for the solution of engineering problems.

Drafting 1 Fundamentals of Engineering Drafting (3)

6 hours of lecture-laboratory
Prerequisite: High school mechanical drawing recommended

Fundamentals of orthographic projection and descriptive geometry as applied to engineering drawings.

Math 1 Applied Technical Mathematics (4)

3 hours lecture, 2 hours problem-solving session
Prerequisite: Intermediate algebra (Mathematics A or equivalent is recommended)

A brief review of geometry; fundamentals of trigonometry. Instruction in graphical and analytical methods and techniques used to solve practical problems involving algebra, geometry, and trigonometry; logarithms and their applications; use of calculators and other computational devices; SI units and English/metric conversions are included.

Theory, problem-solving techniques, and general applications are presented in lectures; treatment of specific problems encountered in concurrent technical course work and other typical engineering problems are included in the problem-solving sessions.

Physics 1 Technical Physics (3)

2 hours lecture, 3 hours laboratory
Prerequisite: Mathematics A and Physics A (or equivalent); Mathematics 1 or 1E is recommended, may be taken concurrently

Lectures, demonstrations, and laboratory exercises in the fundamental concepts of mechanics, electricity, fluids, and heat.

Technical English 1 Communication Skills and Report Writing (3)

2 hours lecture, 2 hours laboratory-conference
Prerequisite: Qualifying score on English placement test

Instruction and practice in communication of both oral and written information. Emphasis on techniques for writing various types of technical communication reports. Assistance with the writing of laboratory reports is provided during the laboratory-conference sessions.

Technology 10 Occupational Safety and Health (2)

2 hours lecture
Prerequisite: None

Employer and employee responsibility, Federal and State legislation, accident reports, industrial hygiene, personal protective equipment, materials handling and storage, guarding machines and mechanisms, hand and portable power tools, fire prevention.

(TECHNICAL ELECTIVE COURSES)

CET 110 Mechanics (3)

3 hours lecture
Prerequisite: Mathematics 1 and Physics 1

Analytical and graphical solution of force problems involving structures in static equilibrium, force vectors, free body diagrams, principles of moments and couples. Problem-solving techniques for practical problems in structural design.

CET 120 Strength of Materials (3)

3 hours lecture
Prerequisite: CET 21

Principles of applied mechanics of materials. Practical solution of structural design problems utilizing stress - strain concepts, analysis of beams, trusses, joints and connections.

CET 130 Hydraulics (3)

2 hours lecture, 3 hours laboratory (or 3 hours lecture)
Prerequisite: Mathematics 1 (may be taken concurrently)

Introduction to the principles of hydrology and hydraulics. Analysis of problems dealing with basic properties of fluids, fluid measurements, orfices, nozzles, weirs, pump characteristics, and open channel flow.

CET 140 Topographic Surveying (4)

2 hours lecture, 6 hours laboratory
Prerequisite: CET 11B

Field and office work applying the various methods of topographic surveying, computations and mapping. Instruction in application of control surveys, the California State Coordinate System, instruction in the use of electronic distance measuring instruments.

CET 150 Route Surveying (3)

1 hour lecture, 6 hours laboratory

Prerequisite: CET 11B

Field and office work dealing with reconnaissance, preliminary, and location surveys. Selection and use of proper equipment and methods to execute route surveys under various conditions.

CET 160 Photogrammetry (3)

6 hours of lecture-laboratory (field trips)
Prerequisite: CET 11B

Principles of terrestial and aerial photogrammetry, flight planning, ground control, geometry of photographs, and photogrammetric measurements and mapping.

CET 200 Special Projects (2-6)

1 hour lecture/conference (minimum), laboratory by arrangement
Prerequisite: Consent of the instructor

Specific projects in Civil Engineering Technology involving field, office, and laboratory work in areas in which students have had sufficient preliminary instructions and/or experience. (Note: This course can provide the opportunity for students to develop technical skills included in several of the courses listed above. It is particularly advantageous when insufficient enrollment prohibits the college from offering regularly scheduled courses.)

CET 300 Work Experience

Units and hours by arrangement
Prerequisite: Enrollment in CET curriculum

Credit for supervised coordinated work experience in industry which contributes to the attainment of the student's vocational objective. (It is recommended that work experience units not be substituted for required technical courses.)

(1) Chemistry 101 Technical Chemistry (4)

3 hours lecture, 3 hours laboratory
Prerequisite: One year high school algebra or qualifying score on placement test, (e.g., eligibility for Math A)

An elementary presentation of the fundamentals of chemistry designed to fulfill the needs of students majoring in technology programs.

Drafting 110 Structural Design Drafting (3)

1 hour lecture, 6 hours laboratory
Prerequisite: Drafting 1; Mathematics 1, and CET 12 are recommended

Basic design of structures constructed with structural steel members and reinforced concrete. Manuals published by American Institute of Steel Construction and American Concrete Institute are used to provide design information. Reinforced concrete and structural steel detailing and drafting techniques in accordance with the current industrial practice are stressed.

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(1) A first course in General Chemistry (Chemistry 1A) may be substituted for Chemistry 101.

Math 2 Advanced Technical Mathematics (3)

2 hours lecture, 2 hours problem-solving session
Prerequisite: Mathematics 1 or 1E

Instruction in applied mathematics including an introduction to the basic concepts of analytic geometry, differential and integral calculus, and statistics; emphasis on applications to problems encountered by the engineering technician. Theory, techniques, and general applications are presented in the lectures; specific applications and problem-solving sessions.

(Note--the objective of this course is to familiarize the student with applications of advanced mathematical techniques and develop greater proficiency in the use of algebra and trigonometry and problem-solving techniques and procedures.)

5. EMPLOYMENT OPPORTUNITIES

a) Students who successfully complete the first semester's technical course work may qualify for employment as "rod man" or "chain man" with a survey party.

b) Students who complete the first year of technical course work satisfactorily will have capabilities for employment as civil draftsman, office or field assistants, and soil test assistant in private civil engineering offices or they may qualify for civil service position - Engineering Aide I.

c) Depending upon the selection of technical elective courses, the graduate will be well qualified for employment as a civil engineering technician in private industry or for civil service classifications Engineering Aide II or higher.

C. CERTIFICATE PROGRAMS

These programs are designed for students who do not desire to (or cannot) complete the degree curriculum. The principle objectives of certificate programs are: 1) to provide an opportunity for the student to develop required (limited) skills for job entry classifications, and 2) to enable those employed to improve their knowledge and develop additional skills which will enable them to qualify for higher level employment.

Various combinations of courses may be selected; however, the two programs listed below are typical:

Surveyor Trainee:		Junior Civil Draftsman (Office Aide):	
Mathematics A	4	Mathematics A	4
CET 11A	3	Drafting 1	2
CET 11B	3	CET 11A	3
CET 24	4	CET 11B	3
		CET 14	3

It should be noted that work experience credit may be integrated into either of the above programs.

D. COMMENTS

1. It is recognized that certain course work can be consolidated into fewer courses than those listed; for example, CET 11B might include some introductory material on topographic surveying or topics from route surveying. Then perhaps the subject matter presented in CET 140 Topographic Surveying and CET 150 Route Surveying could be consolidated into a single course. These possibilities notwithstanding, the outline presented will provide versatility and the opportunity for significant depth in course material.

2. The inclusion of only one course in physics is somewhat questionable. However, proper integration of the required concepts, generally presented in discrete courses in physics, into the technical course work should overcome this possible deficiency.

3. Work experience and project type courses are desirable entities to augment the standard course work offered in the curriculum; moreover, careful monitoring and controlled work experience activities and projects may be used to replace certain formal courses recommended in the curriculum outline. The student should be required to challenge the course thus deleted by passing a comprehensive examination on the course content.

4. It is of paramount importance that the curriculum receive adequate input from the industrial community. Care must be exercised that the curriculum content does not become tailored to an individual segment thereby limiting the scope of employment opportunities available to the student.

PART IV CONCLUSIONS AND RECOMMENDATIONS

At the outset it was presumed that better identification and greater uniformity of community college programs in engineering technology and industrial technology would be desirable and advantageous. During the course of the project this hypothesis was supported by a significant majority of educators and industry representatives. The following conclusions and recommendations are based upon the consensus of all segments that participated in the project--including representatives from industry, community colleges, four-year schools which offer (BET) programs, and graduates of technician programs.

1. There is an earnest need for a total cohesive plan for active communication between any two of, and among, the three constituents of occupational education--industry, colleges, and students.

   Industry should be involved in order to accommodate the need for capable technicians necessary to fill existing and future manpower requirements. Community colleges are the logical source of trained technicians; lacking this source--industry must become involved in additional expensive training programs. Community colleges should be concerned about the needs of students, and consequently the needs of industry. Moreover, without adequate student enrollment it is not possible to sustain the programs.

   The faculty need to be actively involved in order to be aware of the changing technological requirements and needs of the students in order to continually update course and curriculum content and instructional methodology.

   Students need to be involved in order to better identify or develop their talents and interests. Also, they need to better understand the relationship of employment qualifications and their chosen educational objective. With this understanding, students should be better motivated to achieve their educational objective.

All constituents must become actively involved in the need to introduce changes essential to sustain and improve the programs in engineering technology and industrial technology. The need for adequate communication will become increasingly important as the skills and knowledge required by technical manpower becomes more and more complex.

2. In order to promote meaningful communication between any two constituents and among community colleges, industry, and students, it is recommended that workshops be scheduled as an on-going activity. It is further recommended that the Chancellor's Office of California Community Colleges assume an active role in promoting these workshop activities.

3. Communication among community colleges must extend beyond faculty-to-faculty and beyond district boundaries. If optimum quality in occupational education is to be achieved at minimal cost--area planning is essential. It is naive to assume that such cooperative efforts can be achieved easily; however, the benefits which would accrue far outweigh the vested interests and supposed, or real, inconveniences which have restricted such action in the past.

4. Every effort should be made to structure engineering technology and industrial technology programs to provide the student with the opportunity for mobility among the curriculums and for continuing education.

5. Without exception, all industry correspondents endorsed the effort to develop greater commonality in engineering technology (ET) curriculums and industrial technology (IT) curriculums offered by community colleges. Further, the identification of a particular curriculum should be consistent. It is highly recommended that all community colleges designate each curriculum according to the guidelines included in this publication. The curriculum discipline, category, and option (or specialty)

should be included; for example, an ET curriculum in electronics with a special emphasis on computer electronics should be designated by the title "Electronics Engineering Technology--Computers" (EET - computers), an IT curriculum with emphasis on refrigeration would be identified by the title "Mechanical Industrial Technology--Refrigeration" (MIT - Refrigeration). The designation should be used in college catalogs and other college publications. Consistent with their recommendations, industry should acknowledge these titles in job classifications and other employment literature.

6. An apparent need exists for some type of organized procedure to evaluate programs in engineering technology and industrial technology in order to ensure greater uniformity in identity and content. Therefore, it is proposed that the Chancellor's Office, in consultation with community college faculty, prepare a list of qualified persons to evaluate (ET) and (IT) curriculums. The list should be established to include representatives from industry and community college technical education (ET and IT) programs. A team could be drawn from the established list to provide assistance in the evaluation of engineering and/or industrial technology curriculums. Initiative for evaluation should come from the community college.

7. It is essential that the faculty of occupational education programs be knowledgeable about the needs of industry in terms of the current state of the art relative to the curriculum technology. The content of the curriculum must be up-to-date, forward looking, and representative of the latest in good practice. The technology of a year ago may be dangerously obsolete and does not belong in a curriculum that aspires to excellence. To achieve this goal, industry and the college administration should assist the faculty in avoiding experiential obsolescence by providing opportunities for workshops, research projects, studies, and other related activities designed to improve the

quality of instruction. Industry can also provide assistance in the form of summer employment and cooperative industry-education projects for students and faculty.

8. The content of the curriculums outlined in this publication were generally judged by industry as sufficient preparation for job entry and for career advancement. It was noted that the mechanical engineering technician appeared to have greater employment potential than the mechanical industrial technician among the large companies represented at the Industry-Education Workshop. However, it was acknowledged that smaller companies (job shops, service firms, repair and maintenance shops, etc.) do have a greater need for the mechanical industrial technician.

9. Considerable concern was expressed by community college faculty and industry representatives regarding the critical need for adequate time to cover the technical and technical-related course work in the two-year curriculum. Courses which develop adequate technical competence must receive sufficient priority over non-technical courses. Therefore, it is recommended that graduation requirements for students enrolled in engineering technology and industrial technology curriculums be carefully reviewed to ensure adequate time for the presentation of technical courses.

10. Finally, it is recommended that, after careful review of this publication, the reader submit an expression of agreement or disagreement with the publication intent, constructive criticism, and suggested changes to improve the content of this publication to the Chancellor's Office of the California Community Colleges.

APPENDICES

I. PROJECT INFORMATION
   - A. History and Scope
   - B. Procedures and Survey Questionnaire

II. ARTICULATION INFORMATION
   - A. Engineering Technology (BET)
   - B. Industrial Technology (BIT)

III. UNIFIED PHYSICS

IV. REMEDIAL COURSES

V. COMMENTS FROM INDUSTRY

VI. COMMUNITY COLLEGE--RESPONDENTS

APPENDIX I PROJECT INFORMATION

A. HISTORY AND SCOPE

The project was originally proposed and approved in January 1974 after considerable research during the 1973-74 school year. Two discipline areas, electronics and mechanical, were originally considered; however, it was finally decided that the project should include civil and electro-mechanical as well. The primary goals of the project were to identify distinguishing characteristics of occupational programs in Engineering Technology and Industrial Technology and to outline core-curriculum recommendations for programs in the four discipline areas.

B. PROCEDURES AND SURVEY QUESTIONNAIRES

1) A contact letter, including a brief description of the project, was sent to every California Community College. The letter requested a response to include: a) A contact designate at the college who would participate in providing information for the project; and b) A recommendation of a qualified person who would be available to serve on a Statewide Advisory Committee to the project.

Responses were received from 82 individual community colleges. Of the 82 community colleges responding, ten indicated a very limited or no occupational education program in the discipline areas addressed by the project. The 72 remaining community colleges constituted the project sample (approximately 75% of California Community Colleges).

2) A Statewide Advisory Committee of twelve was selected from the many excellent recommendations. The selection of the members was based on the following criteria:

a) Each member should be knowledgeable about community college technical/occupational education.

b) The committee should reflect geographic representation throughout the State.

c) The committee should consist of representation from colleges having small enrollment (2,000-5,000), medium enrollment (5,000-10,000), and large enrollment (over 10,000).

d) The committee should adequately represent the four disciplines involved in the project.

During the course of the project, it was necessary to make some changes in the committee roster; however, the above criteria were maintained. In addition to the Committee, several other individuals contributed to the project.

The first task of the Committee was to draft a rough outline to develop definitional characteristics of Engineering Technology (technician) and Industrial Technology (technician) as applied to community college technician education programs. This draft together with a questionnaire (see Questionnaire A, page 117), also developed by the Committee, was sent to the 72 community colleges--responses were received from 52 colleges.

A summary of the responses was compiled and reviewed by the Committee. By careful analysis of this information and individual consultation with community college and industry personnel, the Committee developed a revised draft. This draft was subsequently refined and appears in this report (Part II, Section D) "ET/IT Curriculum Structure Characteristics".

3) During the summer and fall semester of 1974, the author visited twenty-five community colleges, five State Universities and eight industrial firms which hire significant numbers of technicians. The purpose of this activity was to gather data by interview and observations regarding: a) technician education programs at community colleges, b) four-year programs in Engineering Technology and Industrial Technology from the point of reference of matriculation requirements and opportunities; and c) the employment opportunities for engineering technicians and industrial technicians. See visitation data sheets, pages 120, 121.

4) Discipline sub-committees were established within the Statewide Advisory Committee. These committees were charged with the task of reviewing visitation information provided by the author; reviewing course and curriculum outlines, catalogs, brochures, and other published materials from representative community colleges; soliciting and reviewing information from industry, in order to propose technology curriculums and course contents for the particular discipline.

5) The mechanical discipline was particularly complex; therefore, a special questionnaire survey (see Questionnaire B, page 118) was made to gather additional data in this area. The survey instrument was mailed to 70 colleges (two had previously reported no curriculums in the mechanical area)--62 responses were received. The results of this survey are reported in Part III of this publication.

6) The Statewide Committee reviewed all material in this publication. No claim is made for unanimous accord; however, the author believes the published material is a reasonable consensus of all consultants.

7) Industry-Education Workshop

Significant data had been obtained from industry by various informal methods during the development of the publication draft; however, the workshop provided a forum for dialogue between and among representatives of industry and education as well as a formal review of the publication draft and the employment qualifications of engineering technicians and industrial technicians.

The workshop was attended by 15 industry representatives from San Diego, the Los Angeles area, and the San Francisco Bay Area. Also in attendance were representatives from seven community colleges, three BET and one BIT four-year schools, and two from the Chancellor's Office of California Community Colleges. Although it was necessary to limit the number of participants in order to ensure optimum opportunity for dialogue, it is important to note that the industries represented employ over 6,000 engineering technicians and industrial technicians.

The workshop also provided the opportunity for sub-group sessions to discuss two principal disciplines--electronics and mechanical. During these sessions, the curriculum content and related job requirements were analyzed. Particular attention was given to the interrelationship of the course work included in the curriculum and the job entry requirements for, and career advancements of, the technician.

All consensus recommendations have been incorporated into the publication text.

To supplement the workshop input, eight additional representatives from industry agreed to review the publication draft and submit their comments. A sample of remarks received from the workshop participants and reviews by other industry representatives is included in Appendix V.

VEA SPECIAL PROJECT

CORE CURRICULA - ENGINEERING TECHNOLOGY AND INDUSTRIAL TECHNOLOGY

In order to provide uniform interpretation of the data derived from this questionnaire, we ask that you carefully read the definitions (please see attached dittoed sheets), and answer the following questions accordingly.

Please feel free to contact any member of the Statewide Advisory Committee listed on enclosed roster, if you need additional clarification or information regarding this questionnaire. Thank you very much for your cooperation.

Questionnaire A

1. Do you offer a curriculum in Electrical/Electronic Technology? Yes______ No______

If the answer is yes, how do you classify the curriculum:

Engineering Technology Yes______ No______

Industrial Technology Yes______ No______

Other (please explain) ______________________________

____

11. Do you offer a Mechanical Technology curriculum? Yes______ No______

If yes, please answer the following:

(a) Title(s) used by your college: 1.____________________

2.____________________

3.____________________

(b) Please indicate the classification of the curricula by encircling numbers (per (a) above):

Engineering Technology 1 2 3

Industrial Technology 1 2 3

111. Remarks ____

Submitted by:______________________ College: __________________

JFS
4/74

QUESTIONNAIRE (B)

VEA Special Project
Core Curricula--Engineering Technology and Industrial Technology

The following curricula are assumed to be options (or specialties) within the "mechanical family classification". Please check the appropriate identification* of the curricula offered by (name of college).

Thank you.

Curriculum Title**	(T&I)	(IT)	(ET)
1. Air Condition. & Refrigeration			
2. Aero. Production & Plan.			
3. Aircraft Maintenance			
4. Aircraft Production			
5. Airframe & Power Plant			
6. Automotive Tech.			
7. Diesel Mech.			
8. Fluid Power			
9. Heating & Ventilation			
10. Industrial Tech.			
11. Machine Design			
12. Machine Shop Tech.			
13. Manufacturing Tech.			
14. Marine Mechanics			
15. Material Evaluation			
16. Mechanical-Electrical Tech.			
17. Mechanical Servicing			
18. Mechanical Tech.			
19. Metal Tech.			
20. Metallurgical Tech.			
21. Metrology			
22. Nuclear Tech.			
23. Numerical Control			
24. Plastic Prod.			
25. Production Tech.			
26. Quality Control (Assurance)			
27. Tool & Die			
28. Vacuum Tech.			
29. Vending Machine Repair			
30. Welding			

Other ____

____

* Please use questionnaire supplement for classification definition.
** As listed in "Occupational Programs", CPCC publication.

Remarks: ____

Submitted by ______________________

VEA SPECIAL PROJECT
Core Curricula--Engineering Technology and Industrial Technology

QUESTIONNAIRE (B)--Supplement I

The following definitions and descriptive material are provided in order to standardize the response data. It is conceivable that you will not agree entirely with these definitions and qualifications. If such is the case, you will please include this information in your response.

1) Trade and Industry Curricula

Trade and industry are those curricula which are very closely associated with the crafts. The content of these curricula is heavily oriented toward manipulative skills required by mechanics and craftsmen. Frequently these are certificate programs consisting of less than two years of course work. They are often associated with apprenticeship programs; however, the Associate degree curricula usually afford the graduate greater opportunities for career advancement. In general, there are no discrete mathematic or science courses. The instruction in mathematics and physics is integrated, as required, into technical course work. Formal curriculum prerequisites are not generally required.

2) Industrial Technology Curricula*

Industrial Technology comprises those Associate degree curricula that prepare a person for employment (as an industrial technician) in production, construction, or related fields. These curricula have generally evolved from the inclusion of a greater amount of mathematical, physical science, and technical subject matter than that found in the traditional Trade and Industry curricula. Generally, Industrial Technology curricula provide additional opportunities for career advancement than that afforded graduates of Trade and Industry curricula; however, entry level employment may be quite similar.

3) Engineering Technology Curricula*

Engineering Technology comprises those Associate degree curricula that prepare a person for employment (as an engineering technician) that is in direct support of an engineer--and/or those curricula that serve as lower division preparation for matriculation to a four-year baccalaureate degree program, normally in engineering technology or advanced training.

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*Please see detailed "Curriculum Structure Characteristics" attached Supplement II

(Note: Supplement II is not included. This supplement was very similar to the material found in Part II, pages 14-18.)

VEA Project--Core Curriculum Page 1 of ____________

Visitation Data Sheet

A. Community College: ________________ Enrollment ________________

1. Contact Person/Title ____________________________________

2. Other: Name/Discipline Area Remarks

____

B. Technology Programs	(Circle)	No. Faculty Enrollment
1. Civil	( ) ET IT	________________
2. Electronics (Electrical)	( ) ET IT	________________
3. Electro-Mechanical	( ) ET IT	________________
4. Mechanical	( ) ET IT	________________

(Option/Title(s): ______________________________

5. Other Technology Programs: __________________________

6. Comments: ____

____

C. Relationship of Engineering & Technology Programs

1. Administrative Structure ______________________________

2. Faculty & Facilities (Common or separate) ______________

3. Common Courses (including Engn. & Tech. enrollment) ________

____

Remarks: ____

____

VEA PROJECT--Core Curriculum Visitation Data Sheet Page____ of____

Technology Curriculum____

1. Classification: ET ( ); IT ( ); Degree or Certificate________
2. Curriculum Objective (Employment or transfer goals)
   a. Employment classifications/Job titles and duties of graduates (Follow-up studies available?):________________
   b. BET articulation: (% transfer?):________________________
3. Enrollment: First Year______ Second Year_______ Grad/Year____
4. Curriculum Prerequisites:__________________________________
5. Course work: (included and/or required in curriculum)

   Text used; # sem/quarters; prerequisite(s);
   (obtain course outlines)

   a. Computational Skills Total Units______________

      Algebra_______, Geometry______, Other__________________

      Trigonometry____

      Comments:____
   b. Physical Science Total Units______________

      Physics:____________________ Chemistry:_______________

      Comments: (other courses req.)__________________________

      ____
   c. Technical Skills (on second page--not included)
   d. Communication Skills__________ Total Units______________

      ____
   e. Related Technical Skills (on second page--not included)
   f. General Education (Note Curriculum/Dist. req.) Total Units

      ____
6. General Remarks (on second page--not included)

APPENDIX II ARTICULATION INFORMATION

The primary objective of the curriculums included in this project is to provide instruction which will develop capabilities for employment and for career advancement. The opportunity for continuing education is also taken into account. A significant number of students (approximately 25% is a conservative estimate) who complete a curriculun in engineering technology transfer to a four-year school to continue their education in a BET or BIT program. Some community college students who major in industrial technology (Technician) programs do indeed continue their education; however, the number is significantly smaller than that in the engineering technology program. One reason for this latter fact is the considerable difference between industrial technician programs in community colleges and lower-division requirements for the BIT degree.

On the pages which follow, two important documents have been reproduced.

A. ARTICULATION IN ENGINEERING TECHNOLOGY

The excerpt shown on the next page is from the minutes of the Spring 1972 meeting of Engineering Liaison Committee (ELC) of the Articulation Conference.(1) The proposal was accepted by unanimous vote of the ELC. The significance of this action was to ensure acceptance of Community College credits (as indicated) for matriculation into BET programs. In most cases the student can complete his work for the BS degree with an additional two years work.

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(1) The ARTICULATION CONFERENCE OF CALIFORNIA was originated in 1919 and currently includes representation of five education segments: University of California, California State Universities, California Community Colleges, Independent Colleges, and High Schools. Each segment appoints members to serve on the Articulation Conference Committee and the Administrative Committee.

Liaison and Ad Hoc Committees are established by the Administrative Committee. Liaison Committees deal with continuing relations in a given field. (The Engineering Liaison Committee was the first such committee established.) Ad Hoc Committees are established to deal with specific assignments.

ENGINEERING TECHNOLOGY COMMITTEE
ARTICULATION IN ENGINEERING TECHNOLOGY
Revised 27 December 1971

	Sem. Hrs.	Qtr. Hrs.
Manufacturing Processes Fabrication, Turning, Drilling, Casting, Molding, Joining, Cutting, Arc Welding, etc.	4	6.0
Electrical Circuits & Introductory Electronics with Laboratory, Shop Practices and Instrumentation	6	9.0
Solid Mechanics Scalar Statics, Scalar Dynamics, Strength of Material	8	12.0
Metallurgy or Properties of Engineering Materials	3	4.5
Digital Computer Programming and Applications	3	4.5
Courses in the Selected Option or Specialty up to	18	27.0
Accounting, Production Cost Estimating	3	4.5
Communications English Composition, Public Speaking, Engineering Drawing, Technical Writing	10	15.0
Government and History	6	9.0
Humanities	6	9.0
Psychology and Economics	6	9.0
Health and Physical Education	4	6.0
A Life Science	3	4.5
*Mathematics College Algebra and College Trigonometry, Technical Calculus, and Statistics	12	18.0
**College Physics - General	8	12.0
Inorganic Chemistry	3	4.5

---

*All prerequisite mathematics necessary to start calculus at the 4-year institution must be completed at the community college before transfer in order to be able to complete the B.S. Degree program in two years at the 4-year institution.

**Recommended for all, mandatory for some four-year colleges.

Any combination of courses listed up to a maximum of 105 quarter units or 70 semester units is acceptable.

B. ARTICULATION IN INDUSTRIAL TECHNOLOGY

An AD HOC Committee on Technical Education--Subcommittee on Industrial Technology Articulation (established by the Articulation Conference) developed guidelines for the first two years (60-70 units) of the BIT program. It should be noted that the outline includes "minimum desirable" courses.

There are several community colleges that list "transfer curriculum" in industrial technology; however, these differ markedly from the industrial technician programs included in this publication.

AD HOC COMMITTEE ON TECHNOLOGY EDUCATION
SUBCOMMITTEE ON INDUSTRIAL TECHNOLOGY ARTICULATION

GUIDELINES FOR INDUSTRIAL TECHNOLOGY ARTICULATION

The following courses are presented for consideration as being the minimum desirable to be completed in the first two years of an industrial technology program.

	SEMESTER HOURS
TECHNICAL	
Drafting (one course beyond high school level)	2
Electronics (introductory course with laboratory)	3
Manufacturing Processes (broad scale course)	4
	9
SCIENCE	
Chemistry (general inorganic; some organic topics desirable)	4
Mathematics (one year of problem oriented technical math with the equivalent of two units devoted to introductory calculus)	6
Physics (one year general physics with laboratory)	8
	18
NON-TECHNICAL	
Business	
Accounting	3
Business Law	3
Communications	
Composition	3
Speech	3
Humanities	6
Social Science	
Economics	3
	21

	SEMESTER HOURS
ADDITIONAL COURSES	12-22

Within the scope of Industrial Technology there are various occupations and occupational levels. It is recommended that technical skills be acquired which will qualify a student for employment at the end of his Community College education, regardless of whether he intends to continue towards a bachelors degree or not:

A. Technical track (electrical, mechanical, construction, draftings, etc.). At many Community Colleges the concentration would constitute a major or a substantial portion of a major.

In addition, those who intend to transfer to another institution to continue towards a baccalaureate degree may also select in accordance with the student's particular interest and talents from the following:

B. General Education (completion of courses, leading to fulfillment of requirement).

C. Business (industrial relations, accounting, economics, safety, etc.).

D. Science (statistics, computer science, chemistry, etc.

TOTAL 60-70

NOTE: The student should try to follow the course pattern required of the four-year institution to which he plans to transfer. Students completing 60 units from the above would be able to complete a baccalaureate degree program in industrial technology with an additional 64 to 68 units selected by the four-year institution.

APPENDIX III UNIFIED PHYSICS

Several courses listed in this publication include some unique features and atypical schedule of class sessions and recommended methodology. However, the basic content of the courses is sufficiently similar to courses currently offered by many community colleges and therefore need no additional elaboration.

On the other hand, the course "Unified Physics" is a totally new approach both in presentation and content; therefore, it seems essential to include the following supplementary information.

The basic educational philosophy and concepts for a course in "Unified Physics" were developed by Technical Education Research Center (TERC)(1) as part of the research and development project in Electro-Mechanical Technology. The brief description which follows will illustrate the educational concepts and content of this course.

The primary objective of the courses in Unified Physics is to familiarize the student, at an introductory level, with the manifestation of how energy is transferred, stored, and controlled in engineered systems. The unified concepts approach stresses the interrelationship between systems, thereby allowing for an easier understanding of more complicated systems. It is important to recognize that the body of knowledge included in the courses in Unified Physics is not significantly different from that of conventional physics courses. The essential difference is the manner in which the concepts are treated.

The following outline is a brief description of the topics included in the two semester-courses.(2)

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(1) See: Electro-Mechanical Technology, Final Report, Project No. 8-0219, Technical Education Research Centers, Inc., page 6.

(2) For additional information refer to: Unified Concepts in Physics and Engineering, by Edward Dierauf and James Court, Prentice-Hall, 1976.

UNIFIED PHYSICS I - (FIRST SEMESTER)

Topic 1 Introduction
An introduction to the idea of using unified concepts to describe common relationships among engineering systems (mechanical translational, mechanical rotational, hydraulic and gaseous, electrical, and heat systems).

Topic 2 Review of Mathematics
Topic 3 Review of Physics
A review of technical mathematics and fundamental concepts of physics necessary to pursue the unified concept approach.

Topic 4 Forces
A discussion of forces (force, torque, pressure, electrical potential difference and temperature difference) responsible for moving energy in systems.

Topic 5 Parameters
An introduction of parameters (length, angle, volume, quantity of charge, and quantity of heat). The product of force and parameter is work in each of these systems except for the heat system.

Topic 6 Parameter Rate
A study of parameter time rates of change (velocity, angular velocity, volume flow rate, electric current and heat rate). The product of force and parameter rate is power except again for the heat system.

Topic 7 Resistance and Energy Loss
The development of Ohm's law equivalence of resistance when energy is moved from one place to another in systems. Series and parallel arrangements of resistors are included.

Topic 8 Another System: Magnetism
A discussion of simple magnetic circuits using unified concept analogies.

Topic 9 Capacitance and Potential Energy Storage
An introduction of potential energy storage in such equivalent capacitive devices as springs, reservoirs, electrical capacitors and heated objects.

Topic 10 Inertance and Kinetic Energy Storage
An introduction to the kinetic energy of motion in systems and the equivalent concepts of mass, moment of inertia, fluid inertance and electrical inductance.

Topic 11 Impulse and Momentum
A study of impulse and momentum mainly in mechanical systems.

Topic 12 Energy Transfer and Storage: RC Systems
Topic 13 Energy Transfer and Storage: RM Systems
A treatment of systems with resistance and either potential or kinetic energy storage. Time delays occur in reaching steady state conditions when excitation forces are suddenly applied or removed.

Topic 14 Energy Transfer and Storage: MC and RMC Systems
A study of systems with both potential and kinetic energy storage. Oscillations occur in these systems when excitation forces are suddenly applied or removed.

UNIFIED PHYSICS II - (SECOND SEMESTER)

Topic 15 Forced Oscillations: R, M and C Systems
Topic 16 Forced Oscillations: RC and RM Systems
A study of the equivalent ideas of reactance and impedance in systems excited by a sinusoidal force.

Topic 17 Forced Oscillations and Resonance: RMC Systems
A study of series and parallel resonance in sinusoidally excited systems.

Topic 18 Transformers
A study of transformers that change the form of energy into something more appropriate to a particular engineering application. Examples of transformers are leavers, cams, gears, a hydraulic press, an electrical transformer and an acoustical loudspeaker.

Topic 19 Load Matching
A study of the coupling of energy sources to loads to achieve a desirable match.

Topic 20 Amplifiers
A study of energy amplifiers in electrical and fluid systems.

Topic 21 Energy and Measurement
A discussion of measurement systems and the particular role of the transducer in detecting some measurable quantity and converting a signal to a useful output.

Topic 22 The Control of Energy: Feedback
Topic 23 The Control of Energy: Stability
An introduction of the control of energy in engineering systems. The ideas of feedback and stability are developed.

Topic 24 Waves
A study of energy propagated through mediums in the form of waves.

Topic 25 Radiated Energy
A study of radiant energy and an introduction to the idea of energy present in the photons of quantum physics.

APPENDIX IV MATRICULATION (REMEDIAL) COURSES

The following course descriptions are included to illustrate the level of competency required to meet the recommended curriculum prerequisite and prerequisite requirements for certain technical courses listed in the core curriculum in engineering technology. Detailed descriptions of the content of these courses have been ommitted intentionally inasmuch as the courses are included to provide general or typical guidelines rather than specific content or structure.

Drafting A Fundamentals of Mechanical Drawing (3)

6 hours lecture-laboratory
Prerequisite: None

Use of drawing instruments; geometric constructions and basic concepts of orthographic drawing and sketching, including three-view drawings and pictorials.

Math A Fundamentals of Technical Mathematics (4)

3 hours lecture, 2 hours problem-solving session
Prerequisite: One year high school algebra (or equivalent--qualifying score on placement test)

A brief review of basic arithmetic operations and elementary algebra. Instruction in the fundamentals of algebra, geometry, and right-angle trigonometry with emphasis on problem-solving techniques as applied to typical problems encountered in technology curriculums. Use of computational devices (calculators).

Concepts and techniques are introduced in the lectures; exercises in practical applications and individual tutoring are provided in the problem-solving sessions.

Physics A Elementary Physics (3)

2 hours lecture, 3 hours conference/demonstrations
Prerequisite: Mathematics A or equivalent (Mathematics A may be taken concurrently)

A preparatory course for students who have had no previous experience in physics. Emphasis is on solving problems involving forces, energy, elementary kinematics, fluids, and electricity.

APPENDIX V COMMENTS FROM INDUSTRY

- I reviewed your proposed curricula from the standpoint of the many aerospace companies' technician categories. I find these curricula very much in line with the way I and coherts of mine in the aerospace field think, and know of current and future state-of-the-art electronics in engineering and industrial technology, and the other subject areas which provide the broadening background for the 2-year engineer technician and the industrial technician.

  These curricula will adequately provide the entry level skills and the basis for career advancement.

- For companies involved in electronic and electronic equipment manufacturing, I feel that both engineering technology and industrial technology graduates from electronic technician programs are a must for efficient operation.

  Reviewing the mechanical aspects of electronic equipment manufacturing, the utilization of mechanical engineering technicians is advantageous but I find little need in our operation for their industrial technology counterparts.

  At (------) and in most of the companies, with which I am familiar, I feel that Managers and Recruiters have a very limited knowledge of the education programs and technical competence of the graduates. They know and use certain educational institutions because of successful graduates in their employment.

  If we are effectively going to provide educational programs to efficiently staff industrial organizations, it is imperative that a communication exchange between industry, instructional staffs (not administration) and students (particularly graduates) must take place.

- The content of the curriculums included in the draft would adequately prepare the graduate for employment with (------) and would assuredly provide a reasonable base for career advancement. Positions (job titles) include:

  EET/EIT -- Electronics Technician
  Engineering Technician

  MET/MIT -- Industrial X-ray Technician
  Junior Engineer - Laboratory
  Junior Engineer - Liaison
  Materials and Process Analyst
  Numerical Control Parts Programmer
  Engineering Draftsman
  Quality Assurance Analyst
  Tool Planner
  Weight Analyst

  EMET -- Systems Technician

- I wholeheartedly agree that a commonality or core base should be maintained as strongly as possible. The reasons for this are obvious in that it does help to maintain articulation, meet the needs of a broad age group, and be a marketable program. Of special interest was your observation concerning the electro-mechanical curriculum. I guess the point here really is that if there is a strong specialization, it is difficult to accept the fact that one must learn in another area. With a dual exposure, one can readily adapt and learn greater specialization in areas where they may be somewhat short changed in early training.

- We feel it is our responsibility to pass on technology to industry and education and participate with education to help establish improved programs. The project is important to (------). We have been confused in the past by the inconsistencies (the project is attempting) to eliminate.

- The electronics representatives of the Industry-Education Committee reviewed the Electronics Technology courses for Engineering and Industrial degrees or certificate programs. The consensus was that the Electronics Industrial Technology course and curriculum matched the hiring needs of most of the electronics industry. This, due in part to the entrance level jobs available to community college graduates and secondly to provide job satisfaction for the newly hired graduate - by not educating him/her to the point of being over qualified for the job. Too high a skill level can frustrate a new employee and destroy job achievement satisfaction.

  As the graduate progresses into higher skill level jobs he could be encouraged to return to college for his Electronic Engineering Technology Degree, specializing in areas relating to his job. Future job advancement could involve going after a four year degree.

  Based on this approach, it was recommended that the Electronic Industrial Technology Degree curriculum be so structured as to permit the maximum credits toward an electronic Engineering Technology degree and as practical to provide usable credits toward a four year degree.

- It is obvious that more dialogue between Industry and Technical Educators is mandatory otherwise there will be an acute shortage of technologists and technicians in the foreseeable future.

- I was in general agreement with the apparent conclusions of the group as I interpreted them; that is, that the MIT program, although of lesser importance to the companies represented at the workshop, was nevertheless a worthwhile and needed program.

  My agreement with this conclusion is based on my experience with line organization contacts I made at (------) in preparation for the workshop. In discussion with these supervisors, some favored the MIT curriculum and others did not. As I reviewed my notes I noted this distinction at (-------) those supervisors who were concerned with the early design & development project stages of our work, preferred the MET program; but those supervisors who had organizational responsibilities for making and building things and meeting standards, thought the MIT program would provide better candidates for their work.

APPENDIX VI

COMMUNITY COLLEGE--RESPONDENTS

1. College of Alameda - Warren Susan
   Robert T. Whitmore
2. Antelope Valley College - Robert S. Wolfsohn
3. Bakersfield College - Ed J. Hageman
4. Butte College - John Hopkins
   Raymond Carrozza
5. Cabrillo College - Jack Snyder
6. College of the Canyons - Robert Pollock
7. Cerritos College - Ralph G. Chadwick
8. Cerro Coso Community College - James Sirman
9. Chabot College - Fred Hirsch
10. Chaffey College - Ray Webb
11. Columbia Junior College - Wayne Morrison
12. Compton Community College - Roger D. Beam
13. Contra Costa College - William Lawrence
14. Crafton Hills College - Edward L. Chapin, Jr.
15. Cuesta College - Edwin M. Pearce
16. Cypress College - Allen Mottershead
17. De Anza College - Richard Kent
18. College of the Desert - Lawrence M. Frederick
19. Diablo Valley College - Richard Nordstrom
20. East Los Angeles College - Eli Sandler
    Brinton Mitchell
21. El Camino College - Joseph Dzida
22. Foothill College - Don Leach
23. Fresno City College - David Dickie
    Richard Handley
24. Fullerton College - Rodney O. Houston
25. Gavilan College - Rolf Bruckner
26. Golden West College - Edward Parsons
27. Grossmont College - C. Allen Paul
    Charles Hyde
28. Allen Hancock College - Richard Dixon
29. Hartnell College - Harry McDonald
30. Laney College - Frank Accurso
31. Los Angeles Harbor College - John Quier
    Kenneth Friske
    Jim Harter
32. Los Angeles Southwest College - James R. Heusdens
33. Los Angeles Valley College - Glen H. Thomas
34. College of Marin - James Staley
35. Mendocino College - Douglas Puckering
36. Merced College - W. E. Martineson
    Harry Dotson
37. Merritt College - Herbert F. Lowe

38. Mira Costa College - Millard Lachman
Bruce Stewart
39. Monterey Peninsula College - Joel Readio
40. Moorpark College - Lawrence G. Lloyd
41. Ohlone College - Warren Enos
42. Orange Coast College - Samuel R. Peterson
Stewart R. Powell
43. Pasadena City College - Vernon G. Spaulding
44. College of the Redwoods - E. W. Soper
45. Reedley College - Jack L. Stevenson
46. Sacramento City College - Richard Stockwell
47. San Bernardino Valley College - Henry A. James
48. San Diego City College - C. R. Hamann
49. San Diego Mesa College - Paul Jacot
50. City College of San Francisco - Herbert Naylor
Earl Scribner
51 San Joaquin Delta College - Vic Remillard
Don Mathews
52. San Jose City College - Sidney E. McGaw
Andrew McFarlin
53. College of San Mateo - Gilbert Gossett
Paul Lin
54. Santa Ana College - John Russo
55. Santa Barbara City College - Melvin Elkins
56. College of the Sequoias - Joseph Guarisco
57. Shasta College - James Buckley
58. Sierra College - John Panelli
A. H. Vanderbilt
59. College of the Siskiyous - Paul Dawson
60. Solano Community College - Bill Weber
61. Southwestern College - Vincent Alfaro
Ray Riesgo
62. Ventura College - John Smithson
63. West Hills Community College - Byron Harrison
64. West Valley College - Ted Geredes
65. Yuba College - Earl Orum

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